JULIE N PREASSESSMENT DATA REPORT

Prepared for:

Maine Department of Environmental Protection
Maine Department of Conservation
Maine Department of Inland Fisheries and Wildlife
Maine Department of Marine Resources
National Oceanic and Atmospheric Administration
U.S. Department of Interior

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September 1998

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EXECUTIVE SUMMARY

Natural resource impacts from the *Julie N* oil spill were varied, increasing with proximity to the spill site at the Million Dollar Bridge and heavily contaminated areas such as portions of Portland Harbor and the Fore River. Exhibit 1 below provides a summary of the findings from the studies conducted following the *Julie N* oil spill.

Exhibit 1

***JULIE N* OIL SPILL: SUMMARY OF FINDINGS FROM PREASSESSMENT STUDIES**

Resource	Impacts
Marine Vegetation	Macroalgae: 1,143 square feet and 340 pounds of (primarily) *Ascophyllum sp.* removed. Some *Fucus sp.* possibly removed. Wetlands: 25.61 acres oiled, *Spartina alterniflora* mainly impacted. 14.65 acres were moderately or heavily oiled. The oiling occurred in the Fore River.
Marine Communities: Finfish	The number of fish collected by beach seine in Back Cove (reference station) was 4-5 times higher than the number of fish collected at any Fore River station. However, due to the presence of a school of fish, the sampling effort was not representative of the actual distribution of finfish in the area.
Marine Communities: Shellfish	Lobsters: Total carcinogenic PAH concentrations (relative to Benzo(a)pyrene) in tissue were greater than 16 ppb (the action level) in several lobster samples collected in the middle and outer Fore River, and inner Casco Bay. Of the 34 samples analyzed, 22 indicated a contribution from *Julie N* oil. However a PAH analysis indicates that most of the contamination is due to sources other than *Julie N* oil. Petroleum-sourced PAHs appear to be limited to certain middle and outer Fore River samples. An insufficient number of lobsters from the inner Fore River (i.e., near the *Julie N* spill site) was available for chemical analysis. Relatively high background body burdens of pyrogenic and petrogenic PAHs were detected in lobster samples during source allocation analysis. 107 out of 1,725 sensory evaluations (i.e., odor/taste) detected oil (6.2 percent) although the contamination may have existed prior to the spill. Most detections were in inner and middle Fore River lobster samples. Scallops: Carcinogenic PAH concentrations (relative to Benzo(a)pyrene) ranged from 1.3 ppb-1.7 ppb, and total PAH concentrations ranged from 560 ppb to 1,000 ppb in scallops collected off Eastern Point (Portland) and Cape Elizabeth. PAHs analyzed from collected scallop samples were consistent with *Julie N* oil. Two sensory evaluations detected oil per 200 tests (1 percent). Both positive tests were from the Cape Elizabeth sample location.

Exhibit 1 (continued)

***JULIE N* OIL SPILL: SUMMARY OF FINDINGS FROM PREASSESSMENT STUDIES**

Resource	Impacts
Marine Communities: Shellfish (continued)	Sea Urchins: PAH concentrations in sea urchins collected from Spring Point (South Portland) were 0.71 ppb carcinogenic PAH (relative to Benzo(a)pyrene) and 1,200 ppb total PAH. PAHs analyzed from sea urchin samples were not consistent with *Julie N* oil, and were heavily influenced by pyrogenic PAHs. No oil was detected by the sensory evaluation tests. Blue Mussels: Total PAH concentrations in mussel tissue collected from the Fore River were generally 10-30 times higher than concentrations found in Fore River mussels collected from the same areas in 1994. An elevation in the ratio of both low molecular weight PAHs and alkylated PAHs to total PAHs relative to the 1994 data set was observed, indicating petroleum-sourced PAHs in post-spill mussel samples. Total PAH concentrations were up to 10 times higher in mussels collected in impacted areas of the Fore River (e.g. Thompson Point) relative to mussels from Fore River areas receiving little-to-no *Julie N* oil contamination (i.e., Fore River Cove). With the exception of two samples, one from Fore River Cove and one from Mill Cove, oil fingerprinting analyses of Fore River mussel samples yielded oil contamination that was consistent with *Julie N* oil. Additional sampling of mussels in 1998 indicated that PAH burdens had dropped considerably since the previous sampling efforts. A mussel sample collected from Thompson Point Cove contained 5,800 ppb PAHs. Soft-Shelled Clams: Fore River clam populations had approximately half the total PAH body burdens as did mussels. Total PAH concentrations were up to 8 times higher in clams collected in impacted areas of the Fore River (e.g. Thompson Point) relative to clams from Fore River areas receiving little-to-no *Julie N* oil contamination (i.e., Fore River Cove). An elevation in the ratio of low molecular weight PAHs to total PAHs in clams from impacted Fore River areas relative to Fore River Cove (i.e., reference) clams was observed, indicating petroleum-sourced PAHs in post-spill clam samples. Furthermore, oil fingerprinting analyses of all Fore River clam samples yielded oil contamination that was consistent with *Julie N* oil. Clam samples collected from Thompson Point Cove in February 1998 contained an average PAH concentration of 14,800 ppb.
Marine Communities: Vertical Wall Communities	Observed hydroids and stalked ascidians in the subtidal zone were dead. Substantial freshwater input from the October 20 Northeaster storm event may be responsible for these occurrences. The effects of high-pressure, hot water cleaning of vertical wall communities were not studied, though some adverse effects likely occurred.
Marine Communities: Benthic Organisms	A survey did not detect any gross mortality of benthic organisms.

Exhibit 1 (continued)

***JULIE N* OIL SPILL: SUMMARY OF FINDINGS FROM PREASSESSMENT STUDIES**

Resource	Impacts
Sediment Quality	Total PAH concentrations for inner, middle and outer Fore River sediment samples were higher than concentrations in similarly located sediment samples collected in 1989. Only the outer Fore River post-spill sample was significantly higher than the 1989 outer Fore River sample. Higher ratios of lower molecular weight alkylated aromatic homologues relative to pre-spill samples indicate the presence of petrogenic hydrocarbons. When compared with a post-spill reference area (i.e., Fore River Cove), sediment cores taken from Thompson Point Cove had significantly higher total PAH concentrations. Relative to Fore River Cove (i.e., reference) samples, the ratio of low molecular weight PAHs to total PAHs was higher in all Thompson Point Cove and Long Creek sediment samples, and in one of the samples from both Mill Cove and Airport Cove, indicating recent exposure to a petroleum product. According to the Arthur D. Little, Inc. source oil allocation study (ADL 1997), only 4 of the 25 sediment cores analyzed contain petrogenic PAHs attributable to *Julie N* oil, and these samples contained 13 - 26 percent pyrogenic PAHs. The remaining 21 samples contained a mixture of petroleum PAHs from other sources, pyrogenic PAHs, and trace biogenic PAHs. It should be noted that all sediment samples were collected after the October 20, 1996, Northeaster storm, which may have resulted in the resuspension and redistribution of oil-contaminated sediments in the Fore River.
Bird Impacts	Between September 29 and November 19, 1996, 1,679 birds in the Fore River area showed visible signs of oil: 1,084 were lightly oiled; 508 were moderately oiled; and 87 were heavily oiled. 28 live oiled birds were captured and brought to the rehabilitation center. These totals represent cumulative observations from daily surveys; hence, some birds were probably counted more than once. Twelve birds were rehabilitated and released. One bird remained in rehabilitation and 15 birds died while at the rehabilitation center. Twelve birds found dead were collected.
Water Quality	Water samples collected from the lower Fore River on October 1, 1996 contained between 130 ng/L and 1,300 ng/L total PAH. Samples collected from the upper Fore River between September 30 and October 1, 1996 contained between 433 ng/L and 50,787 ng/L total PAH Oil fingerprinting analysis of water samples indicated that 31 out of 47 samples contained *Julie N* oil residues, with most samples having from 70 to 90 percent petrogenic PAHs. Many of the remaining samples could be conservatively interpreted as containing heavily weathered *Julie N* oil residues. Several water samples contained petrogenic PAH signatures from other (non-*Julie N*) petroleum sources.

Exhibit 1 (continued)

***JULIE N* OIL SPILL: SUMMARY OF FINDINGS FROM PREASSESSMENT STUDIES**

Resource	Impacts
Socioeconomic Impacts	Ferry Transportation: Vessel closure of Portland Harbor resulted in a three-day disruption to Prince of Fundy Cruises Limited service between Portland and Yarmouth, Nova Scotia. 2,700 passengers were re-routed through Bar Harbor, resulting in a cumulative travel time loss of 10,620 hours. 250 trip cancellations resulted. Public Use Areas: The Portland municipal boat ramp was closed for 1.5 days. The Wayneflete School public trail system posted signs requesting that individuals and their pets stay out of contaminated marsh areas between September 27, 1996 and June 30, 1997. This restriction resulted in 1,380 lost trips and 1,380 diminished use trips. Sports Fisheries: Fishing closures impacted various fisheries/geographic areas within the spill exposure zone from September 27th - November 15th. Significant, but unquantified, decreases were observed in shore-based fishing in the Fore River/Portland Harbor area. Approximately 124 party/charter boat-based fishing trips were lost. Fishing equipment sales were significantly lower following the spill. Recreational Boating: Recreational boating was restricted at marinas and mooring areas located within spill safety zones. Cumulative lost boating trips were estimated to be 4,862 trips. Tour Boats: Educational field trips to House Island were canceled. Approximately 300 secondary school students were affected. Whale Watching: Approximately 225 whale watching person-days were lost.

INTRODUCTION CHAPTER 1

At approximately 11:05 a.m. on September 27, 1996 the Tank Vessel (T/V) *Julie N* inbound with a cargo of 8.8 million gallons of #2 Fuel Oil struck the south side of the Million Dollar Bridge, spanning Portland Harbor between Portland and South Portland, Maine, as it went through the draw span. Following the collision, the vessel proceeded one mile up river to the Rolling Mills terminal where it was immediately boomed off. In the collision with the bridge, the T/V *Julie N* received substantial hull damage in the port bow area. Four holds were damaged: the fore peak tank, forward bunker tank, a void tank/space, and the #1 port cargo tank. The forward bunker tank lost 93,198 gallons of IFO 380 heavy fuel oil and the #1 port cargo tank lost 86,436 gallons of #2 diesel, totaling 179,634 gallons of oil spilled (USCG 1996).

Under the Oil Pollution Act of 1990 (OPA 90), the parties responsible for the release of oil are liable for the costs to restore natural resources. Federal and State natural resource trustees may conduct a Natural Resource Damage Assessment (NRDA) to document and quantify injuries to natural resources and their services. The natural resource trustees for the *Julie N* spill include the Maine Department of Environmental Protection (MDEP), Maine Department of Marine Resources (MDMR), Maine Department of Inland Fisheries and Wildlife (MDIFW), Maine Department of Conservation (MDOC), U.S. Department of the Interior (DOI), and the National Oceanic and Atmospheric Administration (NOAA). These groups are working together to determine the impacts of the oil spill on natural resources, with the ultimate goal of developing and implementing a plan to restore those injured resources. These state and Federal agencies comprise the *Julie N* Oil Spill Trustee Council; MDEP is serving as the Lead Administrative Trustee (LAT).

This preassessment data report is a summary of the activities and information currently available on the impact of the *Julie N* oil spill to natural resources. The main objective of this report is to compile all of the available information on response and preassessment activities related to the *Julie N* oil spill. The preliminary injury assessment information contained in this report is intended to assist the federal and state trustees in identifying appropriate future NRDA actions.

The federal and state trustees and the responsible party, Amity Products Carriers, Inc., have agreed to make this study of the *Julie N* oil spill a cooperative assessment. As such, the trustee agencies have made available this preliminary information and data to the responsible party. Since *Julie N* studies to date were conducted under a preassessment context, the study results should be considered preliminary. Conclusions may be modified as more data are collected and more is understood about the effects of the spill.

The remainder of this report is organized as follows. Chapter 2 provides a description of the incident, and a chronology of response and cleanup operations. Chapter 3 provides a description of the chemical properties, toxicological characteristics and environmental fate of # 2 Fuel Oil and IFO380, the two spilled oils. Chapter 4 provides an overview of the preassessment studies conducted in the aftermath of the spill. The studies related to the oil spill are grouped according to six major categories:

- Marine vegetation,
- Marine communities,
- Sediment quality,
- Birds,
- Water quality, and
- Socio-economic considerations.

The appendices to this report include available spill response information (Appendices A-D); copies of the preassessment study reports conducted by the trustees (Appendices E-T); contact information for individuals participating in *Julie N* NRDA activities (Appendix U); and the source oil allocation report (Appendix V).

JULIE N SPILL CHRONOLOGY — CHAPTER 2

The following chronological summary of the *Julie N* oil spill and related response operations is based upon MDEP, United States Coast Guard (USCG) and NOAA response reports. Appendices A, B, and C provide MDEP, USCG and NOAA response reports, respectively.

Day 1: Friday, September 27, 1996

At 11:05 a.m., the Liberian Tanker Vessel *Julie N* struck the south side of the Million Dollar Bridge. Within the next 30 minutes the USCG Marine Safety Office in Portland and MDEP were notified of the incident. At 11:52 a.m. the USCG established a safety zone, closing Portland Harbor to water traffic. The ship was carrying 8.8 million gallons of cargo (#2 Fuel Oil) plus its own propulsion fuel (IFO380). At the time it was unknown how much oil had discharged.

The Million Dollar Bridge had sustained significant physical damage from the collision, causing its closure. Maine Department of Transportation (MDOT) officials estimated it would take weeks to repair the damage.

At 12:17 p.m. the T/V *Julie N*, with tug assist, approached the Sprague Dock.[1] Damage to the ship was visible above the waterline on the port bow. It did not appear that a great deal of oil was discharging from the vessel. The ship was observed to be listing forward. A boom was in place at the Sprague Dock and their contractor, Seacoast Ocean Services, was on scene and ready to deploy containment boom around the vessel. Once moored, the ship continued to list. Substantial quantities of oil, first #2 Fuel Oil then IFO380, began discharging from the damaged area on the hull. Additional booms were placed around the primary boom to help contain the gushing oil. With favorable weather conditions and the vessel effectively boomed, oil recovery at the ship was given top priority. Response resources were mobilized to the site, including equipment from local pollution contractors and area spill response cooperatives. Authorization

[1] The *Julie N* had been under tug assist since prior to its collision with the Million Dollar Bridge.

was given to Clean Harbors to temporarily open the necessary tanks at their terminal to hold recovered oil and water. According to MDEP, the *Julie N* leaked for six hours. Steve McCall of Maritime Overseas Corporation (MOC) reported to the Coast Guard that there was heavy oil in Casco Bay, the Fore River, and Portland Harbor.

Two disc skimmers were operated continuously within the containment boom beginning on the afternoon of September 27th, and continuing through Sunday the 29th. Disc skimmers and oil skimming barges were particularly effective in the early stages of the response. Containment activity continued through the night. While U. S. Coast Guard responders worked to stabilize the ship, MDEP responders supervised and assisted with the deployment of nearly two miles of boom at various pre-planned points. Clean Harbors was contracted to pump out the bunker tank. Arrangements were made to bring the tank barge *BFT300* alongside the ship to receive the transferred fuel. Lightering the vessel had to be done at a very slow rate in order to maintain stability of the ship. Off-loading of the remaining cargo was attempted but ceased when it caused further spillage of bunker fuel.

The spill resulted in the diversion of an international ferry, the *Scotia Prince,* to Bar Harbor; and the closing of all marine fisheries in the immediate vicinity of the spill, including the Fore River and Spring Point (South Portland) to Fish Point (Portland). The Maine Department of Inland Fisheries and Wildlife (MDIFW) led an effort to establish a wildlife rehabilitation center at the South Portland Armory, and began surveying the Fore River and Casco Bay to assess the extent of wildlife and habitat impacts. Citizen calls flooded local 911 operators, voicing health concerns due to petroleum odors that could be detected up to a mile from the waterfront. Overflights of the spill area showed heavy oil concentrations from the bridge to the Sprague Terminal and light oil sheens in Casco Bay. In addition, the National Transportation Safety Board dispatched a crew to investigate the accident.

By early evening the oil was estimated to be several inches thick on the water in portions of the Fore River. It was difficult for responders to distinguish the oil layer on the water due to the night darkness. Skimming equipment supplied by MDEP, Clean Casco Bay, and the Piscataqua River Cooperative, as well as vacuum trucks supplied by local contractors, operated continuously throughout the night. By the next morning it was estimated that about an inch of product remained. More than 60,000 gallons of oil/water mixture were recovered in the first 18 hours of the spill.

Day 2: Saturday, September 28, 1996

During the morning overflight (0825-0915), on-scene winds from the southwest registered at less than 10 knots. Most of the oil was observed along the northern shoreline of the Fore River with the heaviest concentrations between the Veteran's Memorial Bridge and the Interstate 295 bridge. Rainbow and brown sheens were seen under and between the piers along the north shore all the way to the Fore River entrance. Near the river entrance, silver sheens extended from Fish Point to Buoy N6. Transparent sheens were reported in the Presumpscot

River and south of Mackworth Island. No oil was observed in the area west of Cousins Island and the east side of the inner bay. From Spring Point to Cape Elizabeth, no oil was reported. Exhibit 2-1 provides an overview of oil distribution as observed from the morning overflight.

Containment and clean-up activity remained concentrated in the area immediately surrounding the ship. Two to three inches of product were contained within the boom around the ship. Crews were required to reconfigure booms and target pools of oil for cleanup as wind and currents constantly changed. Shoreline cleaning operations were initiated.

Diver Down was hired by MOC to conduct a hull survey. Fuel lightering operations from the #1 port cargo tank stopped due to equilibrium considerations. Twenty-one hundred barrels (bbl) of product were missing from the #1 port tank. The forward bunker tank held 2300 bbl, and had a water bottom. Once the dive was completed, offloading of the vessel commenced in order to bring the ship to an even keel. The #1 port tank hole was still submerged.

State wildlife officials continued surveys of Casco Bay and the Fore River to assess the extent of wildlife impacts. MDIFW implemented the state wildlife rehabilitation plan to set up the rehabilitation center at the South Portland Armory. Tri-State Bird Rescue was contracted by the RP to manage the rehabilitation center under the supervision of MDIFW. Five birds were transported to the rehabilitation center by late in the day. Harbor seals were observed swimming in oily water, and New England Aquarium staff were en route to participate in a rescue, if needed.

Maine Department of Transportation (MDOT) crews along with the help of a construction contractor, Cianbro, worked on the bridge. The bridge fenders were damaged and the basic support for the span was knocked out of alignment. The draw span remained in the "up" position. There was concern that if it was lowered, it would lock, and the upper Fore River would be off limits for an even longer period of time than initially estimated.

Representatives from MDMR, Maine Department of Conservation (MDOC), USCG, and NOAA participated in a scoping shoreline survey by boat of the Fore River areas affected by the spill. Nearly all of the salt marsh vegetation from the I-295 Bridge north to within 1000 feet of the Congress Street Bridge near Stroudwater, then south to and including Long Creek had been heavily oiled, both vertically and horizontally. However, during a shoreline survey by foot, it was observed that the oil on the vegetation could be washed off by relatively gentle water flushing. The rest of the oiled shoreline was composed of riprap and man-made structures (piers). In most cases, the degree of oiling on shore was high. Furthermore, the low viscosity oil penetrated the coarse fill/riprap material in some areas to depths greater than one foot.

At the end of the day nearly 300,000 gallons of oil/water mixture had been recovered. An estimate of the oil/water ratio was not available.

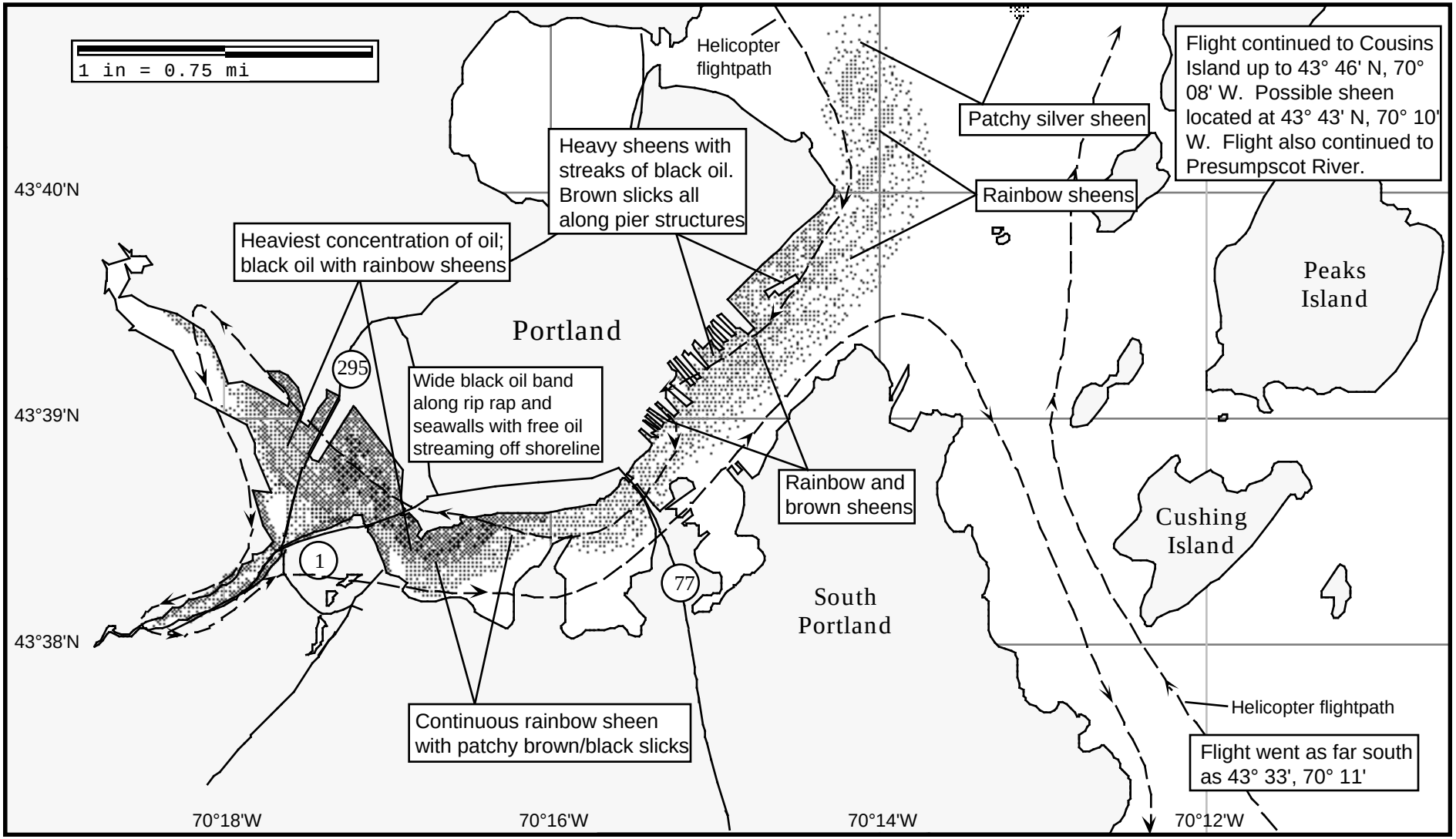
Tanker JULIE N Incident — Exhibit 2-1

Overflight Map
prepared by NOAA

Date/Time: 28 SEP 96, 0825-0915
Platform: Bell Helicopter
Observers: Michel, Simecek-Beatty (NOAA)

USE ONLY AS A GENERAL REFERENCE

Graphic does not represent precise amounts or locations of oil



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Day 3: Sunday, September 29, 1996

Due to 30 knot winds the previous night, most of the oil was observed to be on the Portland side of the river (Exhibit 2-2). There were still large amounts of oil located between the Million Dollar Bridge and the Veterans Memorial Bridge. The Stroudwater marsh area had pockets of black oil. As Exhibit 2-2 illustrates, the ribbons of oil visible between Peak's and Great Diamond Island were scattered silver and rainbow sheens. The oil visible west of Great Diamond Island was in the form of light isolated silver sheens.

The T/V *Julie N* still contained nearly all of its remaining cargo. Offloading was delayed until the bunker tank was completely emptied and no longer posed a threat of discharge. Divers hired by MOC determined that the hole in the ship's hull measured 30 by 15 feet, extending from the forward bunker fuel tank to the #1 port cargo tank.

Detailed shoreline surveys of the oiled marsh/tidal flat areas were determined to be difficult due to limited access across extensive tidal flats and the risk of disturbances resulting from the surveys themselves. Detailed aerial photography (1 inch = 200 feet) was identified as the preferred method for determining the extent of vegetation oiling.

To date, ten live oiled birds had been brought to the oiled wildlife rehabilitation center at the South Portland Armory. One of these birds died at the center.

Harbor traffic remained closed to deep draft vessels. The *Scotia Prince* had to be diverted again as did a container vessel. The Million Dollar Bridge underwent repairs and was expected to open in time for the Monday commute. Approximately 286,000 gallons of oil/water mix were recovered.

Day 4: Monday, September 30, 1996

Winds were from the northwest at five to ten knots. Very little free-floating oil was observed in the western end of the Fore River due to a maximum ebb tide. The heavy concentrations of oil previously observed along the northern shoreline of the Fore River were slowly moving towards the river entrance (Exhibit 2-3). Pockets of black oil were draining off oiled shoreline just east of the Interstate 295 Bridge. Black oil drained off oiled shoreline at the entrance of a small creek just east of the Congress Street Bridge. Scattered sheens extended into the Fore River Sanctuary. Large amounts of black oil were observed along the shoreline and at China Pier. Small amounts of brown oil and silver sheens were observed moving out of the river entrance (Exhibit 2-3).

It was reported that 563,758 gallons of oil/water were recovered to date. Shoreline segments (zones) were delineated to facilitate management of the shoreline cleanup process. Appendix D of this report provides a geographic breakdown of operating zones.

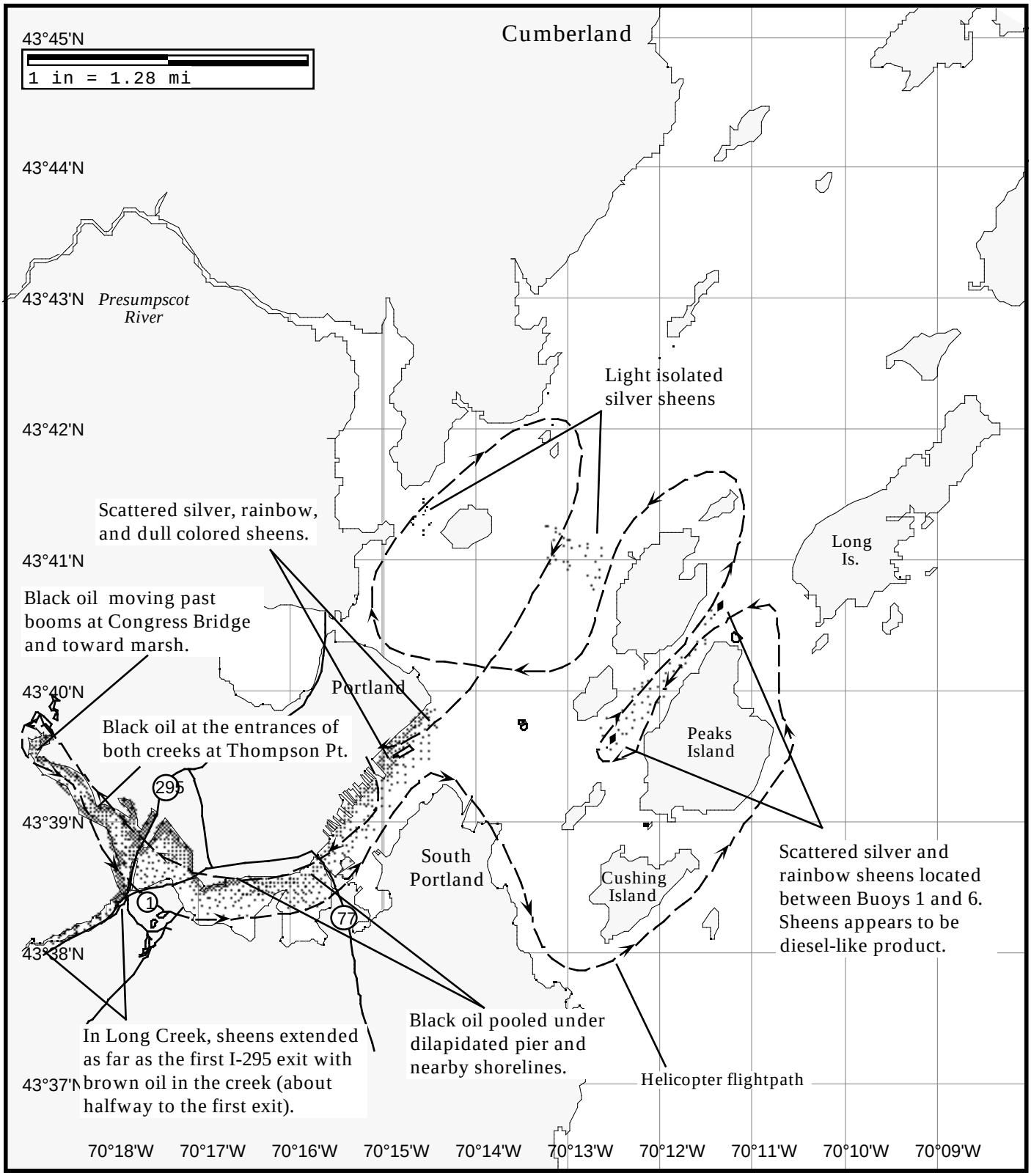
JULIE N Incident — Exhibit 2-2

Overflight Map
prepared by NOAA

Date/Time: 29 SEP 96, 0920-1000
Platform: Bell 206
Observers: Mauseth (Beak), Simecek-Beatty (NOAA)

USE ONLY AS A GENERAL REFERENCE

Graphic does not represent precise amounts or locations of oil



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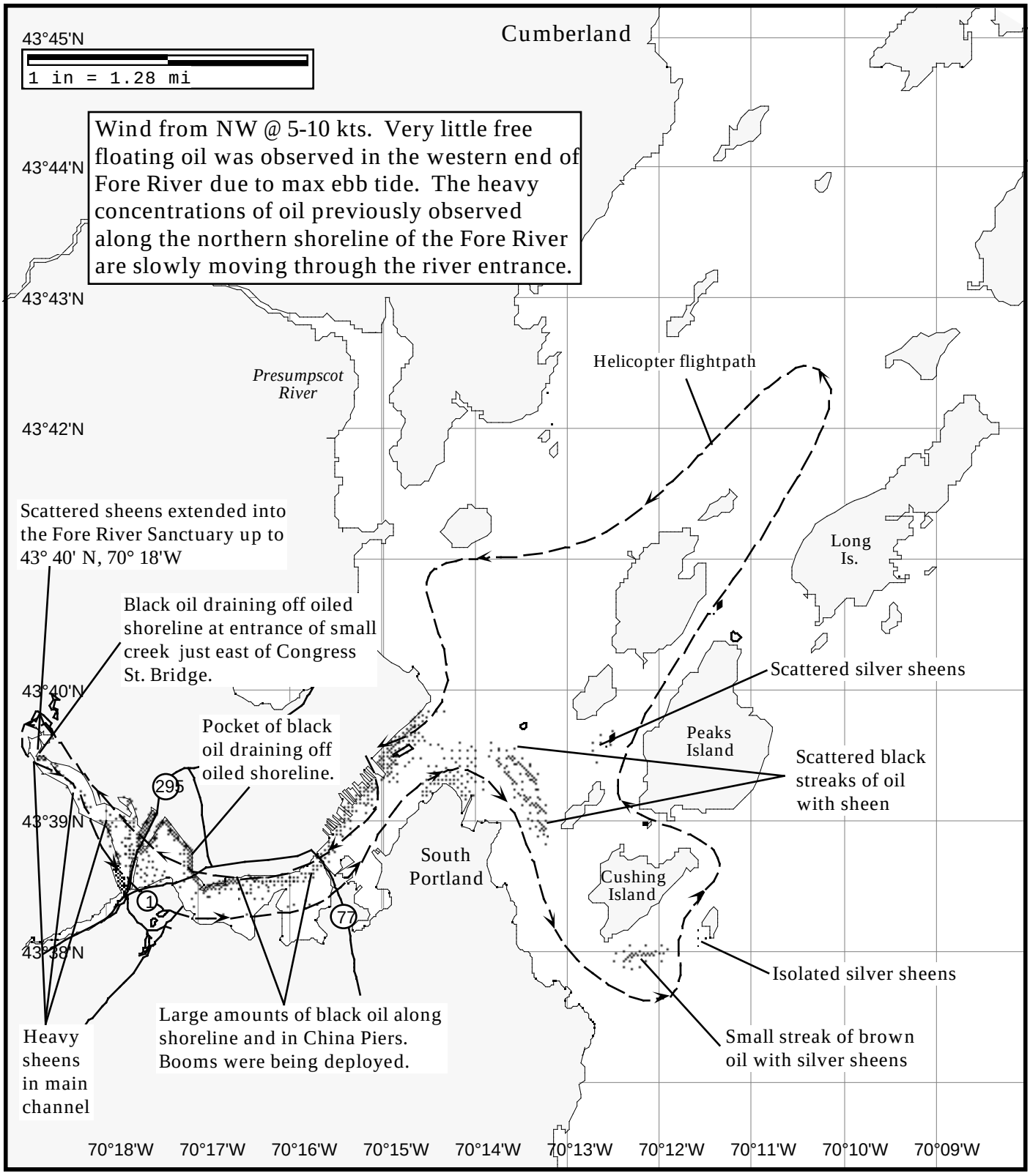
JULIE N Incident — Exhibit 2-3

Overflight Map
prepared by NOAA

Date/Time: 30 SEP 96, 0845-0915
Platform: Bell 206
Observers: Salisbury, Barker (ME DMR), Mierzykowski (USFWS) Simecek-Beatty (NOAA)

USE ONLY AS A GENERAL REFERENCE

Graphic does not represent precise amounts or locations of oil



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The international ferry, *Scotia Prince*, and a container ship were allowed to use a marine terminal down river from the Million Dollar Bridge. The Coast Guard focused on opening the inner harbor area to ship traffic.

More contaminated birds were reported. To date, eleven oiled birds entered the wildlife rehabilitation center. Two of these birds died.

Day 5: Tuesday, October 1, 1996

During the afternoon overflight, winds were from the southwest at 10 knots. Outside the Fore River, the only significant oil observed from previous observations was a small brown patch off Pomroy Rock. Inside the river, the amount of free floating oil had been reduced. The largest amount of contained oil was at the China Clay Pier (Exhibit 2-4).

Shoreline surveys were conducted along the south shore of the Fore River. New shoreline contamination was reported in Mill Cove. The shoreline consisted of fill and fringing salt marsh, and there was extensive oiling along several hundred feet of shore. High-volume, ambient water flushing was conducted at (cleanup operating) Zone 3A, along a riprap/fill area. The method was effective in removing some pooled oil; however, the heavy surface coating remained. The Responsible Party planned to start high-pressure, hot-water washing once all of the mobile oil was removed by flushing. A reported 677,880 gallons of oil/water were recovered.

The status of closed fisheries remained unchanged. Approximately 7,000 lobster traps were exposed. The aerial extent of the fishery closures was approximately 61 square miles (Exhibit 4-37).

Day 6: Wednesday, October 2, 1996

During the morning overflight, winds were from the southwest at 5 to 10 knots inside the Fore River and from the southwest at 10 to 15 knots in the inner bay. The majority of sheens observed in the Fore River appeared to be emanating from piers, boats, and response equipment (Exhibit 2-5).

The Regional Response Team (RRT) was convened and approved the test application of Corexit 9580 on the marsh vegetation at Thompson Point marsh. The shoreline cleanup assessment team conducted detailed surveys of the heads of both Thompson Point marsh and a smaller marsh creek nearby where pooled oil had been reported. No significant amounts of pooled oil were observed at Thompson Point. Recommended cleanup actions were to recover the loose sorbent pads laying on the marsh and deploy a snare on a rope up the center channel, using stakes to keep it off the marsh. In addition, more sorbent was recommended to be added at the mouth in anticipation of oil re-mobilization with northerly winds. The smaller creek had some pooled oil on the unvegetated surface, and a low-pressure flushing operation was recommended

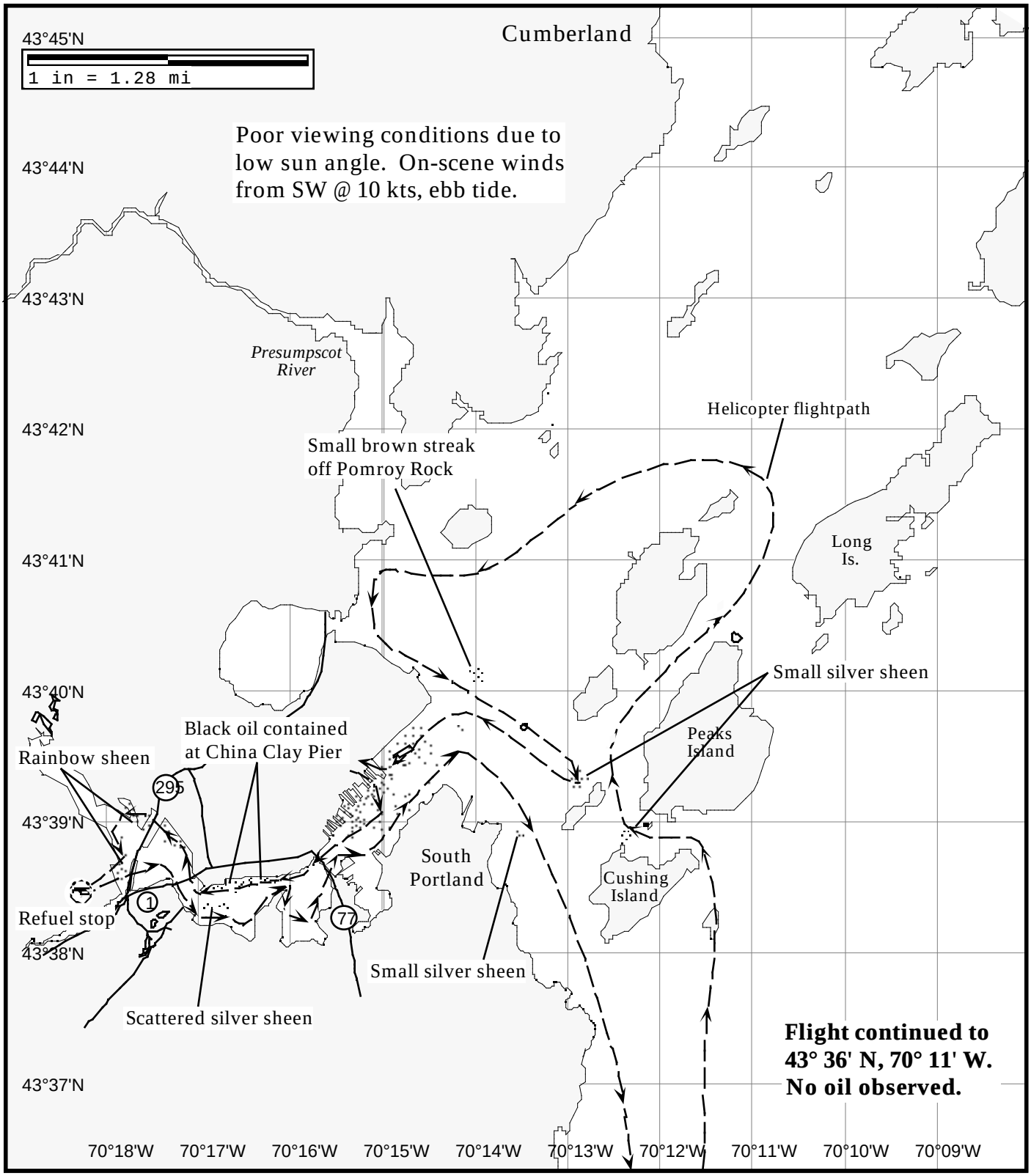
JULIE N Incident — Exhibit 2-4

Overflight Map
prepared by NOAA

Date/Time: 01 OCT 96, 1650-1720
Platform: Bell 206
Observers: Peek (USCG), Simecek-Beatty (NOAA)

USE ONLY AS A GENERAL REFERENCE

Graphic does not represent precise amounts or locations of oil



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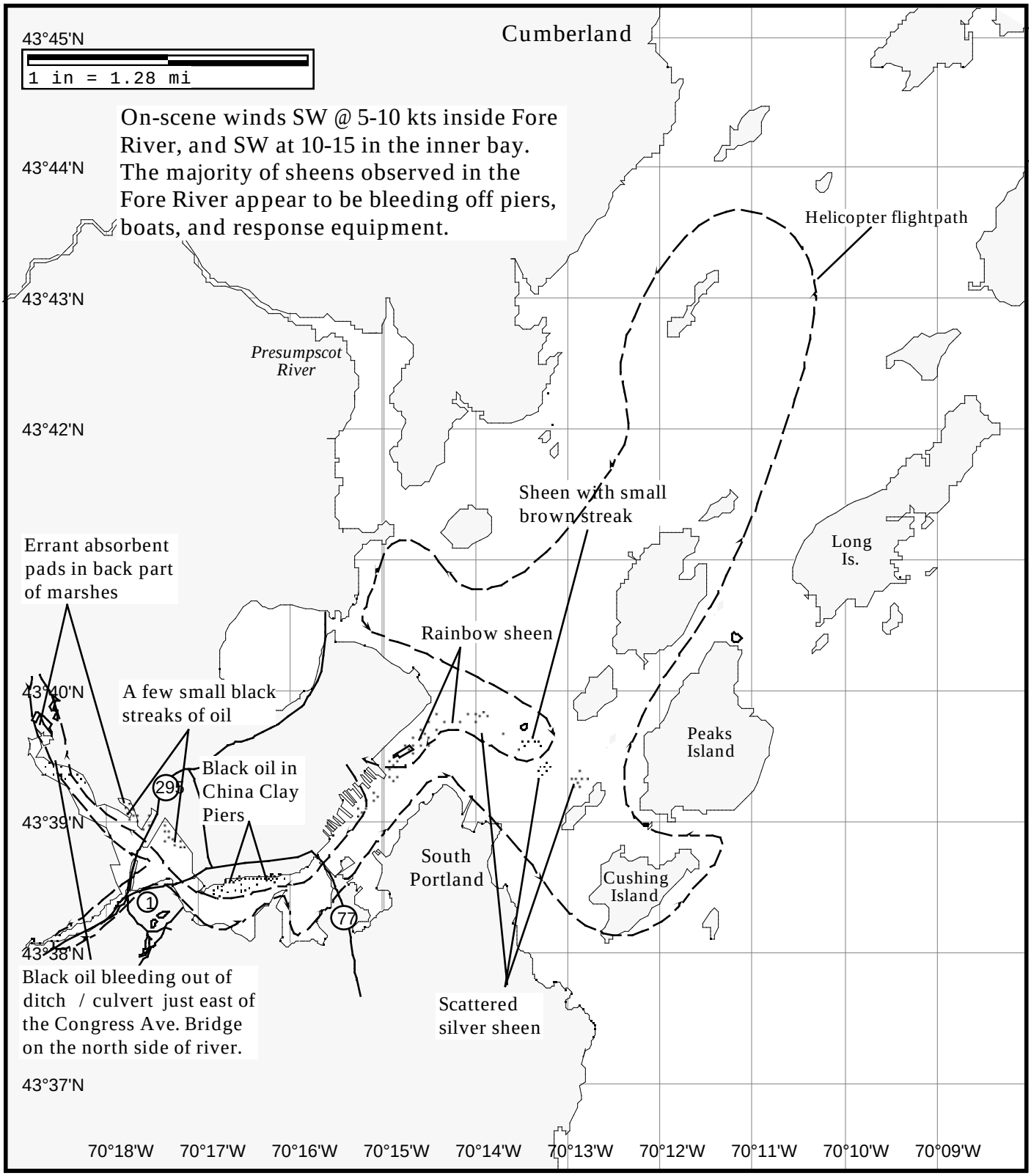
JULIE N Incident — Exhibit 2-5

Overflight Map
prepared by NOAA

Date/Time: 02 OCT 96, 0835-0915
Platform: Bell 206
Observers: Wilson (NRC), Lehmann, Simecek-Beatty (NOAA)

USE ONLY AS A GENERAL REFERENCE

Graphic does not represent precise amounts or locations of oil



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in conjunction with snare deployment. The Fore River Sanctuary marsh was surveyed, and cleanup of the light-to-moderate fringe oiling was not recommended. However, an improved booming strategy for the mouth was suggested.

As of October 2, 17 oiled birds had been brought to the wildlife rehabilitation center; 11 had been stabilized and treated, and six had died.

Day 7: Thursday, October 3, 1996

During the morning overflight, visibility was excellent. Winds were from the northwest at 20 knots with whitecaps visible. Scattered rainbow sheens in Fore River were observed west of the Million Dollar Bridge (Exhibit 2-6).

Ground surveys conducted by MSRC and USCG on the southwest corner of Peaks Island noted oil-stained boats, buoys, and pilings in the marina, and pea-sized tar balls. No sheen was observed in this area.

The shoreline cleanup assessment team conducted surveys to identify sites where seaweed could be removed. They also identified heavily oiled pilings and piers which required hot wash. Cleanup recommendations were submitted to the operations group. Representatives from NOAA, MDEP, and the RP conducted field surveys to identify the locations of transects for ground-truthing the interpretations of oiled vegetation from the aerial photography conducted following the spill by the responsible party. Field forms and detailed field methods/terms were finalized. The ground-truth surveys were scheduled to begin on Friday and continue for two to three days. Aerial photographs (1:2400 scale) were identified for use in finalizing field surveys. A preliminary map of the degree of shoreline oiling was prepared, but it was planned to be finalized from the aerial photography.

The final operational plan for the Corexit 9580 test on the marsh at Thompson Point was reviewed with representatives from all Trustee agencies and the Responsible Party. The test was scheduled for 0800 on Saturday morning.

MOC proposed a vessel-cleaning plan for *Julie N.* A vessel discharge plan was also proposed. In addition, oiled boat cleaning operations were set up at Spring Point Marina, Gowen Marine, and South Port Marina.

As of October 3, 19 oiled birds had been entered into the center for cleaning; 10 were alive and nine had died.

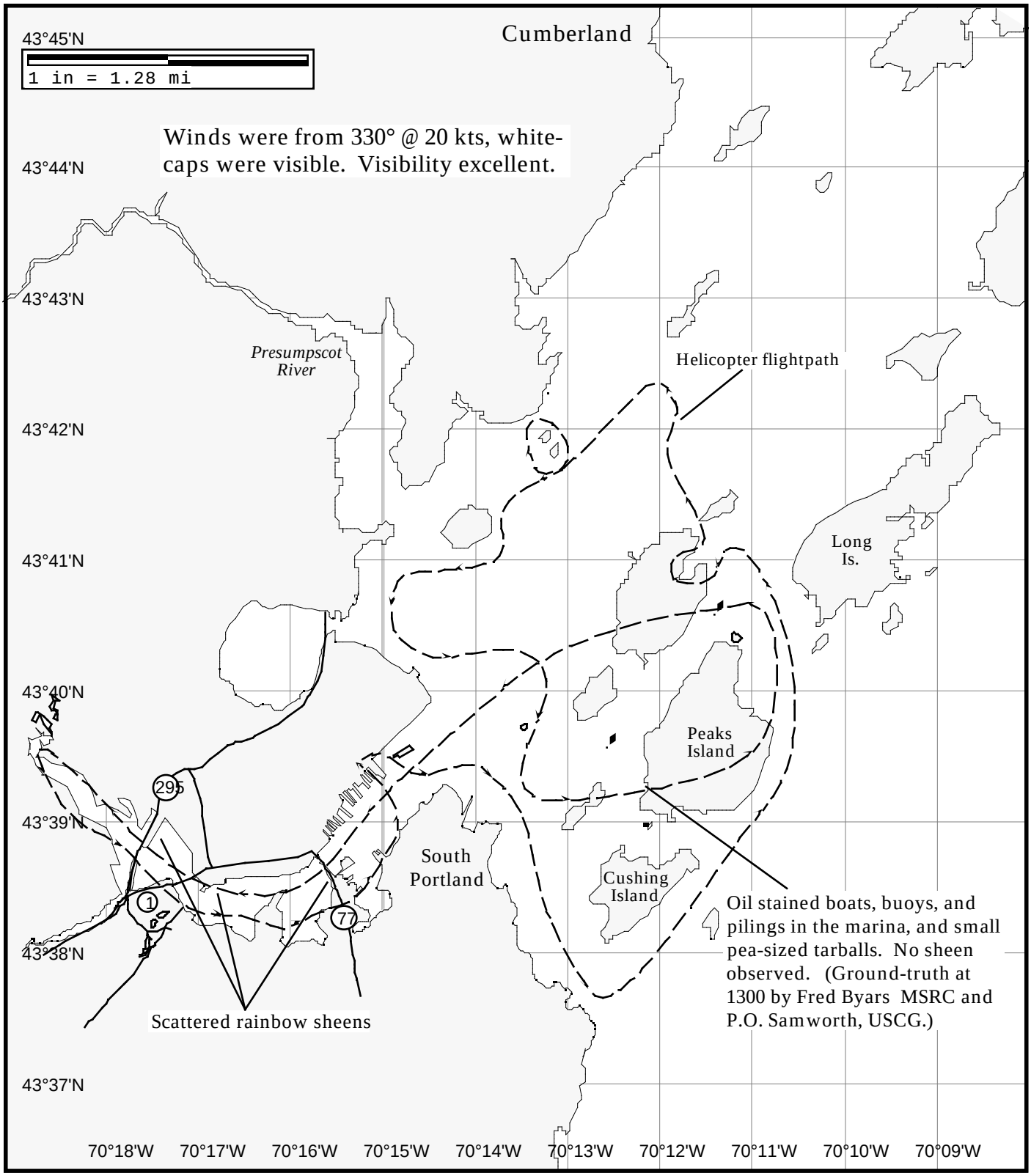
JULIE N Incident — Exhibit 2-6

Overflight Map
prepared by NOAA

Date/Time: 03 OCT 96, 1107-1135
Platform: Bell 206 Long Ranger
Observers: Mauseth (Beak) Barker (DMR), Lehmann (NOAA)

USE ONLY AS A GENERAL REFERENCE

Graphic does not represent precise amounts or locations of oil



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Day 8: Friday, October 4, 1996

An overflight showed no heavy oil visible on the water. Approximately 718,200 gallons of product/water mixture had been recovered as of 0700. No estimate was available on the percentage of oil in the mixture.

A process was underway to slowly raise the bow of the *Julie N* out of the water by strategically offloading or moving cargo. This would expose the hole in the side of the vessel and enable the remaining oil in the damaged tanks to be safely recovered. The vessel would depart for repairs when the exposed tanks were completely clean.

Operations had transitioned from open-water recovery to shoreline cleanup. Approximately 14 miles of shoreline were oiled in the Fore River. Sorbent boom, pads, and snares (pom-poms) were deployed in several areas to capture any sheens mobilized by tidal action. Ambient water flushing was used to clean oiled riprap; however, hot wash was planned for future cleaning of riprap. Oiled boat cleaning stations were established at Spring Point, Gowens and South Port Marine.

Revised marine fishing closures by MDMR resulted in a 10.98 square mile closure for all fisheries, and a 79.05 square mile closure for bivalves (Exhibit 4-37). No additional animals were brought to the rehabilitation center. One additional bird in the center died.

Day 9: Saturday, October 5, 1996

Scattered light streamers of sheen were observed near the *Julie N*, booms, and skimming operations in the Fore River during the afternoon overflight (Exhibit 2-7).

A test application of Corexit 9580 was conducted on marsh vegetation at Thompson Point. The test was observed by MDEP, MDMR, USF&W, NOAA, USEPA, and Responsible Party personnel. The application of Corexit was confined to exposed surfaces. The areas that were exposed showed good removal of oil but the undersides remained heavily oiled. The vegetation that was knocked down by the flushing regained a more erect posture within a few tidal cycles after flushing was stopped. The tide had dropped near the end of the test, exposing sediment. Workers sprayed the sediment in attempts to mobilize any oil left stranded by the falling tide. The treated vegetation looked much cleaner though a heavy stain remained. The undersides were unchanged. The amount of black oil released from the marsh was estimated at 40 to 50 percent of the amount of oil in the test area. It appeared that the treated oil was not as adhesive as before. The adjacent water did cloud up, but water samples collected did not show much visual evidence of suspended oil. The agency representatives present recommended that use of Corext 9850 should not continue because 1) the vegetation was not visibly cleaned enough to warrant the risks of introducing more oil into the water column and sediments; 2) it appeared that a significant amount of the released oil was not immediately recoverable; and 3) the test site represented the best operational considerations in terms of good access and even then the effectiveness was limited.

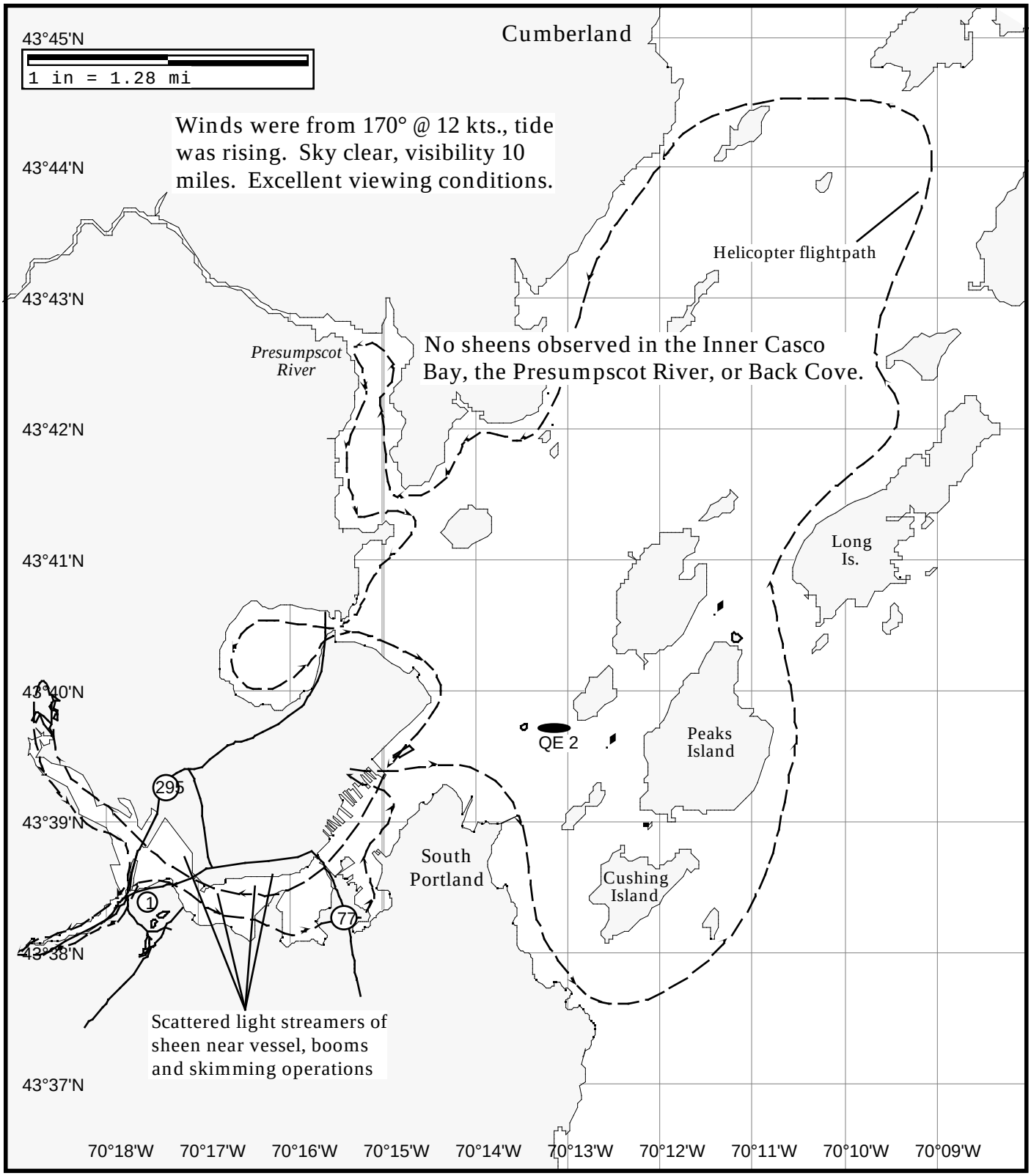
JULIE N Incident — Exhibit 2-7

Overflight Map
prepared by NOAA

Date/Time: 05 OCT 96, 1415-1450
Platform: Bell 206 Long Ranger
Observers: Tordoff, Nadeau (USEPA), Hall, Sites (NOAA)

USE ONLY AS A GENERAL REFERENCE

Graphic does not represent precise amounts or locations of oil



10051415 CJH

Day 10: Sunday, October 6, 1996

The process to slowly raise the bow of the *Julie N* out of the water to expose the damaged tanks continued. The vessel will depart for repairs when the tanks are completely clean.

Cleanup operations were confined to the Fore River where approximately 14 miles of shoreline are oiled. Riprap was cleaned using ambient water flushing. Sorbent boom, pads, and snares (pom-poms) were deployed in several areas to capture sheens. Planned hot wash of riprap and bulkheads did not take place due to operational problems. A fourth boat-cleaning station was opened at Portland Yacht Services. The China Clay docks still had free oil.

Day 11: Monday, October 7, 1996

NOAA coordinated an oiled vegetation countermeasures meeting with several "stake-holder" organizations to discuss options for treating oiled vegetation. The stakeholders included MDEP, MDMR, MDIFW, USFWS, NOAA and the RP. Non-stakeholders included the Federal On-Scene Coordinator (FOSC), SST, RP's Science Team and USEPA. The two options open for consideration were cutting the oiled vegetation and "no action." There was concern from MDIFW and USFWS about leaving oil in the marsh and possibly exposing migrating waterfowl and wading birds. The alternative concern was for the health of the habitat after cutting. While the actual cutting would likely not injure the plants, as they had begun to become dormant, the disturbance of the substrate during cutting operations could cause significant damage. Consensus among the group was for the no-action alternative.

The shellfishing ban was lifted outside the Fore River by MDMR (Exhibit 4-36). Water and tissue chemistry, along with sensory analysis testing satisfied the state's protocol for lifting the fishery closure.

A dead seal was found in the Fore River. The National Marine Fisheries Service (NMFS) was contacted and the RP arranged for a refrigerated truck to transport the animal to the New England Aquarium for testing.[2]

Day 12: Tuesday, October 8, 1996

The Responsible Party was invited by the Trustee Council to participate in a cooperative natural resource damage assessment (NRDA). The RP accepted this offer. Amity Products Carriers, Inc. agreed to pay for NRDA preassessment studies mutually agreed upon by the RP and the Trustees as necessary to make initial determinations as to whether any natural resources were impacted by the spill.

[2] Laboratory analyses eventually indicated that the *Julie N* oil spill was not responsible for the death of the seal.

Cleanup progressed at China Clay docks. Most contaminated boom was taken to the decontamination center. The hot wash cleaning technique was more effective than cold wash. With regard to boat cleaning, the Spring Point cleaning station was working best, with South Port Marine having minor problems with leakage. Gowen's Marine berms were weak and leakage occurred.

A second oiled vegetation countermeasures meeting with the stake-holder organizations was held to confirm proposed actions. The stake-holders included MDEP, MDIFW, USFWS, NOAA and the RP. Non-stakeholders included the SST and the RP's Science Team. Two areas in the Thompson Point Marsh were cut for scientific purposes. Although the RP provided funding for the cutting, they did not support the action. The two areas will be monitored by Maine State agencies to measure/document recovery. The marsh is owned by Waynefleet Academy (a local private school).

Day 13: Wednesday, October 9, 1996

Due to high winds and heavy weather, field operations were sharply curtailed.

Day 14: Thursday, October 10, 1996

Necropsy test results from the dead seal found on October 7 indicated that the seal did not die as a result of oil contamination. Also, the Unified Command approved vegetation cutting in marsh areas at Thompson Point. The experimental marsh grass cutting operation at Thompson Point concluded.

Day 15: Friday, October 11, 1996

Hot wash continued along manmade structures. Heavily oiled rockweed was removed in identified areas. The temperature of the hot wash was increased from 40 degrees Celsius at the pump to a higher temperature necessary to generate 40°C at the nozzle.

NOAA and an MDEP representative visited sites in Zone 3 (i.e., China Clay Docks) to discuss the complete removal of heavily oiled rockweed. Pending concurrence with MDMR, recommendations were planned to be sent to the Unified Command.

Day 16: Saturday, October 12, 1996

A portion of Thompson Point marsh (delineated as JNC-1) was cut beginning at 0900 and ending at 1020. The recovery of the cut grasses continued for some time after the cutting was complete. The project included five small boats. The largest john boat had two personnel with large weed-whackers. The other boats were collecting cut material and supervising the cut. All

boats used push-poles fashioned from an industrial dust mop head with the dusting cloth removed. This provided a large "foot" for pushing the boats through the marsh without penetrating the surface of the intertidal substrate. During and before the cut, MDIFW personnel observed one great blue heron in the marsh. This was the only wading bird observed close to the cutting operation. The heron had oil on its legs, but no oil was observed on any other part of its body.

In addition, the Fore River was opened to lobster fishing (Exhibit 4-36 presents the chronology of the fishing closures).

Day 17: Sunday, October 13, 1996

A second dead harbor seal was found at Bath Iron Works Sunday morning. The National Marine Fisheries Service (NMFS) coordinated with the New England Aquarium Stranding Network and the seal was placed in a refrigerated truck and shipped to the laboratory for analyses.[3]

Thompson Marsh area JNC–2, the sheltered cutting area, was cut with success.

Day 18: Monday, October 14, 1996

During an overflight of the entire spill zone, winds were from the west, west/northwest at 14 to 16 knots. Visibility was good to excellent. The purpose of the flight was to sign-off the off-shore portion of Zone 5. No oil was seen outside the Fore River. Inside the Fore River, east of the Million Dollar Bridge, two very light silver sheens were seen, one of which was clearly related to a fishing vessel which sank the previous week. West of the Million Dollar Bridge, rainbow sheens, some heavy, were visible in oiled marshes.

Hot wash continued along manmade structures. Heavily oiled rockweed was removed in identified areas. In these areas, temperature was no longer an issue and the Unified Command agreed to increase the nozzle temperature at the discretion of the Zone Manager. For the riprap at China Clay Docks (a site of some of the heaviest oiling), a high-pressure washer on an articulating arm attached to a backhoe was brought on-site. Black oil, often in skimmable quantities, was cold and hot water flushed over riprap and at a sand and gravel beach north/northeast of the ship location (i.e., Zone 3A).

[3] Laboratory analyses eventually indicated that the *Julie N* oil spill was not responsible for the death of the seal.

Day 19: Tuesday, October 15, 1996

A gross necropsy was performed on the second seal found dead at the spill site. This seal, like the first, appeared to have died quickly, with a full stomach of herring. Both appeared to be healthy before their deaths. There was some concern expressed by New England Aquarium specialists that these deaths were unusual and not necessarily consistent with oil contamination. A detailed necropsy was planned to be performed by the Armed Forces Institute of Pathology (on contract to NMFS).[4]

The articulating arm, high-pressure washer on a backhoe used for the riprap at China Clay Docks was reported to be quite successful. Black oil and emulsified oil were removed from the area in large quantities. Also, Zones 2XX and 2E were signed off with no maintenance (see Appendix D for Zone locations).

To date, a total of 28 oiled birds were captured alive and transported to the wildlife rehabilitation center at the South Portland Armory. Fifteen of these birds died at the center. Of the remaining 13 birds, 11 were released on October 14 in the vicinity of Wells, ME, and two birds were transported to the Wildlife Center, Cape Neddick, ME (1 was later released, and the second bird, a Ring-billed Gull, was kept at the Wildlife Center because of its flightless condition from old injuries). The Wildlife Rehabilitation Center at South Portland Armory was officially closed due to no additional oiled birds being captured. Arrangements were made to take any additional oiled birds to a local rehabilitator.

Day 20: Wednesday, October 16, 1996

A seal-monitoring plan was presented to the Science Unit of the Unified Command by NMFS. The plan was tentatively approved for action as part of the preassessment program by the RP. Also, hot work began on the vessel. The bow was reinforced and some steel removed from the ship.

Day 21: Thursday, October 17, 1996

A memorandum was sent from Steve Lehmann (NOAA Scientific Support Center) to the Unified Command identifying pooled oil discovered at the southern end of Thompson Point marsh among the *Spartina patens* grasses. The memorandum recommended ambient-temperature water, low-pressure, high-volume flushing. Sorbents were recommended for recovery of freed oil. Additionally, it was recommended that foot traffic be kept to a minimum.

A third dead seal was found at the cruise liner pier. Indications were that it died from something other than oil contamination.

[4] Ibid.

Day 22: Friday, October 18, 1996

A draft memorandum from Steve Lehmann to the Unified Command indicated that oiled sediments were found on the north shore of Long Creek. The memorandum recommended removal of oiled sand by hand only.

The lobster fishery in the upper Fore River was re-closed after a couple of lobsters were reported to have a slight oily odor (Exhibit 4-36). There was concern expressed that the cause might be the washing operations forcing sediment-entrained oil into the water column or onto the river floor. There was no direct evidence of this occurring.

Day 23: Saturday, October 19, 1996

The *Julie N* was released from Sprague Dock to anchorage in Hussey Sound.

Day 24: Sunday, October 20, 1996

A Northeaster storm hit the southern Maine area. Winds in excess of 40 knots and heavy rains continued through Monday night. Flooding and wind damage was reported at numerous locations.

Riprap in several high impact areas continued to have oil cover. In some areas pooled oil was visible on the sides of the rocks. It was unclear how effective the hot-water, high-pressure washing operations would be in removing this oil. Where the oil was heavy in the pebble areas, a subsurface, three-inch thick oil band remained.

Day 25: Monday, October 21, 1996

As a result of the Northeaster storm, on Monday morning all shoreline cleanup operations were halted for safety reasons. By Monday afternoon, a state of emergency was declared for several southern Maine areas, including the City of Portland. All low-lying areas were to be evacuated, which included the command post.

The FOSC, State On-Scene Coordinator (SOSC), RP Science Representative, RP NRDA consultant and SSC conducted a site survey at the height of the rain storm to discuss continued cleanup activity in several severely impacted areas. Along the northern shore of the Fore River, an industrial area, oil had penetrated into course sediments as much as 8 inches. In some places, tarmat was forming on the surface in small patches. During the rains, these sediments were producing rainbow and brown sheens, with brown oil released when saturated sands were shoveled into the flow. Riprap in this area had been cleaned on the front surface. Oil remained under, behind and along the sides of some riprap areas.

Day 26: Tuesday, October 22, 1996

The Northeaster, with winds in excess of 40 knots, had produced as much as 18 inches of rain in parts of southern Maine. By Tuesday morning the rain had reduced, and the command post was again operating. Many roads were washed out or damaged; cleanup crews were chasing freed boom, boats and sorbent; and the City of Portland was without public water in many areas.

The T/V *Julie N* remained at anchorage until the local severe weather ceased, allowing for safe passage. Also, the lobster fishery in the upper Fore River remained closed. Hot-water, high-pressure washing operations were ceased per direction of the FOSC.

Day 27: Thursday, October 24, 1996

The status of cleanup operations is presented below (see Appendix D for maps and descriptions of cleanup zones).

Zone 1 signed off without maintenance
Zone 2A signed of with maintenance
Zone 4.5 - 4.6 signed off without maintenance
Zone 4.7 - signed off with maintenance
Zone 4.8 - 4.9 signed off without maintenance
Zone 4.1 1 - 4.12 signed off without maintenance

Day 34: Thursday, October 31, 1996

The status of cleanup operations is presented below (see Appendix D for maps and descriptions of cleanup zones).

Zone 2F: Maintained sorbent boom
Zone 3A.2 - 3A.3: Manually furrowed shoreline with garden rakes and warm water flushed in flagged areas, recovered released product with sorbents, removed and replaced dirty sorbents as needed, flushed with PVC pipe in place
Zone 3C.7: Flushed sediment in designated areas
Zone 3C.8 - 3C.9: Hot washed designated areas
Zone 3C.10: Decontaminated equipment as required, cleaned and flushed identified areas
Zone 3C.12: Deployed snare on a rope among contaminated rip-rap.
Zone 2-4: Collected, removed and replaced containment and sorbent boom.

Bea Strong (MOC) requested the removal of rip rap in zone 3A.2 due to a safety hazard to workers.

Day 35: Friday, November 1, 1996

The status of cleanup operations is presented below (see Appendix D for maps and descriptions of cleanup zones).

Zone 2F: Maintained sorbent boom
Zone 3A.2 - 3A.3: Manually furrowed shoreline with garden rakes and warm water flushed in flagged areas, recovered released product with sorbents, removed and replaced dirty sorbents as needed, flushed with PVC pipe in place
Zone 3C.7: Flushed sediment in designated areas
Zone 3C.8 - 3C.9: Hot washed designated areas
Zone 3C.10: Decontaminated equipment as required, cleaned and flushed identified areas
Zone 3C.12: Deployed snare on a rope among contaminated rip-rap
Zone 2-4: Collected, removed and replaced containment and sorbent boom.

Day 36: Saturday, November 2, 1996

The status of cleanup operations is presented below (see Appendix D for maps and descriptions of cleanup zones).

Zone 2F: Maintained sorbent boom
Zone 3A.2 - 3A.3: Manually furrowed shoreline with garden rakes and warm water flushed in flagged areas, recovered released product with sorbents, removed and replaced dirty sorbents as needed, flushed with PVC pipe in place
Zone 3C.7: Flushed sediment in designated areas
Zone 3C.8 - 3C.9: Hot washed designated areas
Zone 3C.10: Decontaminated equipment as required, cleaned and flushed identified areas
Zone 3C.12: Deployed snare on a rope among contaminated rip-rap
Zone 2-4: Collected, removed and replaced containment and sorbent boom.

Day 37: Sunday, November 3, 1996

The status of cleanup operations is presented below (see Appendix D for maps and descriptions of cleanup zones).

Zone 2F: Maintained sorbent boom
Zone 3A.2 - 3A.3: Manually furrowed shoreline with garden rakes and warm water flushed in flagged areas, recovered released product with sorbents, removed and replaced dirty sorbents as needed, flushed with PVC pipe in place
Zone 3C.7: Flushed sediment in designated areas
Zone 3C.8 - 3C.9: Hot washed designated areas, clean spud pipes

Zone 3C.10: Decontaminated equipment as required, cleaned and flushed identified areas
Zone 3C.12: Deployed snare on a rope among contaminated rip-rap
Zone 2-4: Collected, removed and replaced containment and sorbent boom.

Day 38: Monday, November 4, 1996

The status of cleanup operations is presented below (see Appendix D for maps and descriptions of cleanup zones).

Zone 2F: Maintained sorbent boom
Zone 3A.2 - 3A.3: Manually furrowed shoreline with garden rakes and warm water flushed in flagged areas, recovered released product with sorbents, removed and replaced dirty sorbents as needed, flushed with PVC pipe in place
Zone 3C.7: Flushed sediment in designated areas
Zone 3C.8 - 3C.9: Hot washed designated areas, clean spud pipes
Zone 3C.10: Decontaminated equipment as required, cleaned and flushed identified areas
Zone 3C.12: Deployed snare on a rope among contaminated rip-rap
Zone 2-4: Collected, removed and replaced containment and sorbent boom.

Day 39: Tuesday, November 5, 1996

The status of cleanup operations is presented below (see Appendix D for maps and descriptions of cleanup zones).

Zone 2F: Maintained sorbent boom
Zone 3A.Z - 3A.3: Manually furrowed shoreline with garden rakes and warm water flushed in flagged areas, recovered released product with sorbents, removed and replaced dirty sorbents as needed, flushed with PVC pipe in place
Zone 3C.7: Flushed sediment in designated areas
Zone 3C.8 - 3C.9: Hot washed designated areas, clean spud pipes
Zone 3C.10: Decontaminated equipment as required, cleaned and flushed identified areas
Zone 3C.12: Deployed snare on a rope among contaminated rip-rap
Zone 2-4: Collected, removed and replaced containment and sorbent boom.

Zone 2B signed off without maintenance. Zone 2F signed off without maintenance. Zone 2C signed off with maintenance. Zone 2D signed off without maintenance. Zone 4.10 signed off without maintenance. Zone 4.1, 4.3, 4.4 signed off without maintenance. Zone 4.2 needed boom maintenance at Portland Fish Pier near *Wrangell.*

Day 40: Wednesday, November 6, 1996

The status of cleanup operations is presented below (see Appendix D for maps and descriptions of cleanup zones).

Zone 2F: Maintained sorbent boom
Zone 3A.2 - 3A.3: Manually furrowed shoreline with garden rakes and warm water flushed in flagged areas, recovered released product with sorbents, removed and replaced dirty sorbents as needed, flushed with PVC pipe in place
Zone 3C.7: Ensured area free of debris
Zone 3C.8 - 3C.9: Prepared to hot wash designated areas if required.
Zone 3C.10: Decontaminated equipment as needed, cleaned and flushed identified areas
Zone 3C.12: Deployed snare on a rope among contaminated rip-rap.
Zone 2-4: Collected, removed and replaced containment and sorbent boom.
Zone 3A.4: Signed off without maintenance.
Zone 3A.1 - 3A.3: Signed off with maintenance.
Zone 3C.1 - 3C.7: Signed off with maintenance

Day 41: Thursday, November 7, 1996

The status of cleanup operations is presented below (see Appendix D for maps and descriptions of cleanup zones).

Zone 2F: Maintained sorbent boom
Zone 3A.2 - 3A.3: Manually furrowed shoreline with garden rakes and warm water flushed in flagged areas, recovered released product with sorbents, removed and replaced dirty sorbents as needed, flushed with PVC pipe in place
Zone 3C.7: Ensured area free of debris
Zone 3C.8 - 3C.9: Prepared to hot wash designated areas, if required.
Zone 3C.10: Decontaminated equipment as needed, cleaned and flushed identified areas
Zone 3C.12: Deployed snare on a rope among contaminated rip-rap
Zone 2-4: Collected, removed and replaced containment and sorbent boom.

Caleb Brett's report showed that 2058 bbl of # 2 fuel and 2218.74 bbl of bunker fuel discharged. Total of 4276.74 bbl (179,623 gal) lost. 3356.56 bbl (140,976 gal) recovered. A total of 78 percent of spill was recovered. Note: these spillage volumes are slightly different than spillage volumes published by the U.S. Coast Guard (however, volumes recorded in reports vary by much less than one percent).

Day 42: Friday, November 8, 1996

The status of cleanup operations is presented below (see Appendix D for maps and descriptions of cleanup zones).

Zone 2F: Maintained sorbent boom
Zone 3A.2 - 3A.3: Zone signed off, cleaned area of all debris and equipment except as required for maintenance
Zone 3C.7: Ensured area free of debris
Zone 3C.8 - 3C.9: Ensured area is clear of debris and response equipment
Zone 3C.10: Decontaminated equipment as required, cleaned dock structure as instructed
Zone 3C.12: Checked area and ensured all snare, equipment and debris were removed
Zone 2 - 4: Collected. removed and replaced sorbent boom as required.

Day 43: Saturday. November 9, 1996

The status of cleanup operations is presented below (see Appendix D for maps and descriptions of cleanup zones).

Zone 3C.10: Decontaminated equipment as required

Day 48: Thursday, November 14, 1996

The status of cleanup operations is presented below (see Appendix D for maps and descriptions of cleanup zones).

Zone 3C.12: Signed off with maintenance

Day 66: Monday December 2, 1996

Coast Guard declared the spill clean-up complete.

Day 67: Tuesday, December 3, 1996

The sign-off team completed a survey of zones: 2A, 2C, 2E, 3A.1 - 3A.3, 3C.1 - 3C.12, and 4.7. The survey team signed-off zones with the understanding that further maintenance may be required pending a post-winter assessment.

CHARACTERISTICS OF SPILLED PRODUCTS CHAPTER 3

INTRODUCTION

The collision of the *Julie N* with the Million Dollar Bridge resulted in the release of both #2 Fuel Oil and IFO380. A summary of the fate and effects of #2 Fuel Oil and IFO380 oil spills in the marine environment can be found in Exhibits 3-1 and 3-2, respectively. These exhibits describe general fate and effects of the types of oil spilled but are not specific to the *Julie N* spill. Specific chemical characteristics of the two types of oil were identified through analyses of samples collected during response operations (Henry 1996) and in support of several preassessment studies (ADL 1996). Samples analyzed during *Julie N* response operations by Louisiana State University will be discussed below as they provide a synopsis of the chemical characteristics of *Julie N's* cargo (#2 Fuel Oil, also known as oil product "BF59") and the vessel's fuel (IFO380, also known as oil product "BF60"). Source oil analyses conducted by Arthur D. Little are also presented below. Results from water, sediment, and tissue samples analyzed during preassessment activities will be presented in the appropriate sections of Chapter 4 and several appendices of this report.

IFO380 AND NUMBER TWO FUEL OIL CHEMICAL CHARACTERISTICS

The ship's fuel was a heavy black oil characteristic of a residual fuel oil (Henry 1996). Exhibit 3-3 is a chromatographic comparison of the IFO380 from the *Julie N*, IFO380 from *Buffalo 292* (the Spring 1996 Galveston, Texas oil spill), and a "typical" Bunker C fuel, incorporating oils with a wide range of physical and chemical properties. The oil identified as typical is an EPA reference Bunker C, and appears to be a good, middle-of-the-range standard. Exhibit 3-3 shows that the *Julie N* oil is similar in profile to a typical bunker C.

Exhibit 3-4 is a chromatographic comparison of the *Julie N* reference bunker fuel, the *Julie N* #2 Fuel Oil cargo, and a second #2 Fuel Oil from the recent *North Cape* incident. As the exhibit indicates, there are strong similarities in the composition of the middle distillates used in production of both the IFO 380 (the ships fuel) and the #2 Fuel Oil (the cargo oil). The petroleum distillates used in the #2 Fuel Oil represent a more narrow fraction or composition, i.e., from less

than nC-9 to approximately nC-27 (Exhibit 3-5) while the IFO380 incorporates this same fraction plus a heavier distillation cut, exceeding nC-36 and heavy residual (asphaltene) fraction (Exhibit 3-6).

Exhibit 3-1

#2 FUEL OIL SPILLS: GENERAL FATE AND EFFECTS[1]
(Based on NOAA 1996b)

#2 fuel oil is a light, refined petroleum product with a relatively narrow boiling range, meaning that, when spilled on water, most of the oil will evaporate or naturally disperse quickly (usually within a few days).
When spilled on water, #2 fuel oil spreads very quickly to a thin film. Even when the oil is described as a heavy sheen, it is 0.0004 inches thick (only a fraction of the thickness of a piece of paper) and contains about 1,000 gallons per square nautical mile of continuous coverage. Silver sheen contains about 75 gallons per square nautical mile. Thus, recovery efforts are most effective where the oils is trapped against the shoreline or in booms.
#2 fuel oil has a very low viscosity and is readily dispersed into the water column when winds reach 5-7 knots or sea conditions are 2-4 foot waves.[2]
#2 fuel oil is much lighter than water (specific gravity is about 0.85, compared to 1.03 for seawater). It is not possible for this oil to sink and accumulate on the seafloor as pooled or free oil.
It is possible for the oil to be physically mixed into the water column by wave action, forming small droplets that are carried and kept in suspension by the currents.[3]
#2 fuel oil is not very sticky or viscous, compared to black oils. When the oil strands on the shoreline, it tends to penetrate porous sediments quickly, but also to be washed off quickly by waves and tidal flushing. Thus, shoreline cleanup is often not needed for small accumulations.
#2 fuel oil is readily and completely degraded by naturally occurring microbes, under time frames of one to two months.
In terms of toxicity to water-column organisms, #2 fuel oil is considered to be one of the most acutely toxic types, partly because of its tendency to naturally disperse in the water column. However, spills in open water are so rapidly diluted that fish kills are seldom observed. Fish kills have been reported for the small spills in small streams or confined, shallow water.
In shallow, nearshore areas, #2 fuel oil, if in adequate quantity, can taint lobsters and shellfish which take up the oil. However, these animals also flush the oil out, usually over a period of ten weeks after exposure.
#2 fuel oil spills can affect waterfowl and marine birds by direct contact. Mortality is caused by ingestion during preening as well as drowning and hypothermia from matted feathers.
Notes: [1] The fate and effects of #2 fuel oil described in this exhibit are general observations regarding #2 fuel oil spills and not necessarily specific to the #2 fuel oil spilled from the *Julie N*. [2] In the *Julie N* spill, these conditions may have occurred in Casco Bay; they probably did not occur in the Fore River. [3] It is reasonable to assume that the relatively calm winds during the first 24 hours after the *Julie N* spill did not significantly contribute to vertical mixing of oil into the water column during this period of time.

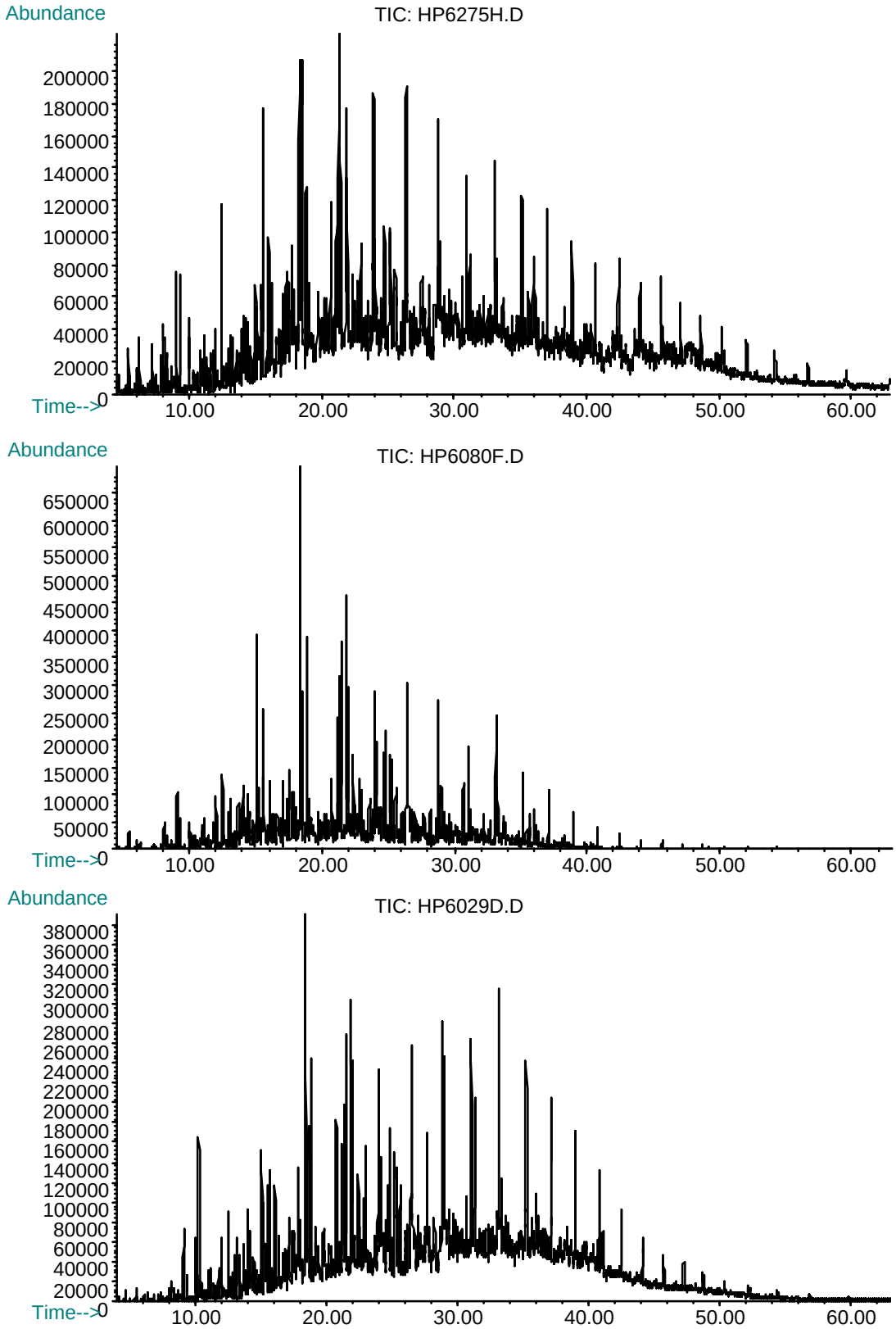
Exhibit 3-2

IFO380 FUEL OIL SPILLS: GENERAL FATE AND EFFECTS
(Based on NOAA 1996b)

IFO380 is an intermediate fuel oil produced by blending a heavy-type oil (#6 Fuel Oil) with #2 Fuel Oil. Thus, it is characterized as a persistent oil; only about 5-10 percent is expected to evaporate within the first hours of a spill.
When spilled on water, IFO380 spreads into thick slicks which can contain large amounts of oil. Oil recovery by skimmers and vacuum pumps can be very effective, particularly early in the spill.
Very little of this viscous oil is likely to mix into the water column. It can form thick streams or, under strong wind conditions, break into patches and tarballs.
The IFO380 fuel oil which was spilled has a specific gravity of 0.972; it is characterized as a heavy oil. But it is still too light to sink, even in fresh water.
However, some of the oil could potentially sink once it strands on the shoreline, picks up sediment, and then is eroded by wave action.
IFO380 fuel oil can be very viscous and sticky, meaning that stranded oil tends to remain on the surface. Light accumulations usually form a "bathtub ring" at the high-tide line; heavy accumulations can pool on the surface.
Heavy accumulations of seaweed wrack on the shoreline can actually act as a natural sorbent.
Shoreline cleanup can be very effective, particularly soon after the spill before the oil weathers, becoming stickier and even more viscous. Removal is also needed because degradation rates for heavy oils are very slow, taking months to years.
In contrast to #2 Fuel Oil, IFO380 is not expected to have much toxicity to animals in the water-column. Toxicity is more related to smothering effects and sediment contamination.
Direct mortality to waterfowl from exposure to slicks can be high, especially where birds are concentrated in specific areas, such as during migration.
Direct mortality rates are generally lower for shorebirds because they rarely enter the water. Sublethal effects from either reduced or contaminated prey are more likely for shorebirds because they feed in intertidal habitats where oil strands and persists.
The biggest factors in controlling the impacts of IFO380 fuel oil contamination on marshes are the extent of oiling on the vegetation, the degree of sediment contamination (either from the spill or resulting from the cleanup) and whether or not the oiling occurs during the growing or dormant season.
Many plants can survive partial oiling; fewer survive when all or most of the above-ground vegetation is coated with heavy oil during the growing season. Oiling of only the above-ground vegetation during the dormant season does not result in mortality.
However, unless the substrate is heavily oiled, the roots often survive and the plant can re-grow.
Heavy, viscous oils tend to remain on the substrate surface, reducing the risk of sediment contamination and long-term impacts on surviving plants.
Note: The fate and effects of IF0380 fuel oil described in this exhibit are general observations regarding IFO380 fuel oil spills and not necessarily specific to the IFO380 fuel oil spilled from the *Julie N*.

Exhibit 3-3

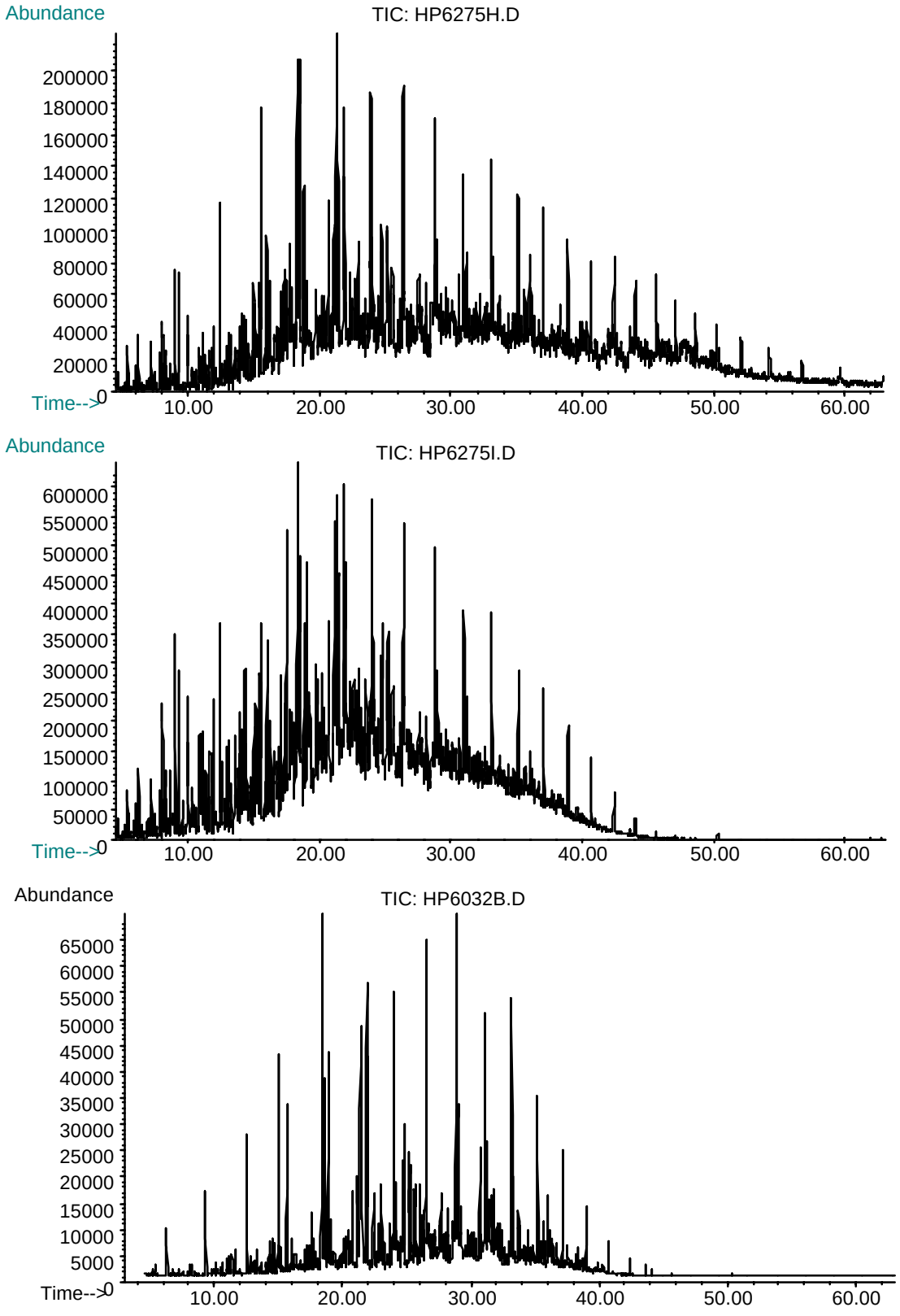
IES/RCAT96-44



Chromatographic profile (TIC) of the IFO380 from the *Julie N.* (top), IFO380 from Buffalo 292 (middle), and a typical Bunker C (bottom). (Based on Henry 1996)

Exhibit 3-4

IES/RCAT96-44



Chromatographic profile (TIC) of the spilled IFO380 (top), Fuel Oil #2 from the *Julie N.* (middle), and the North Cape Incident (bottom).
(Based on Henry 1996)

Exhibit 3-5

Analyte Histogram for *Julie N* #2 Fuel Oil (BF59 Cargo Oil)

(ADL 1996)

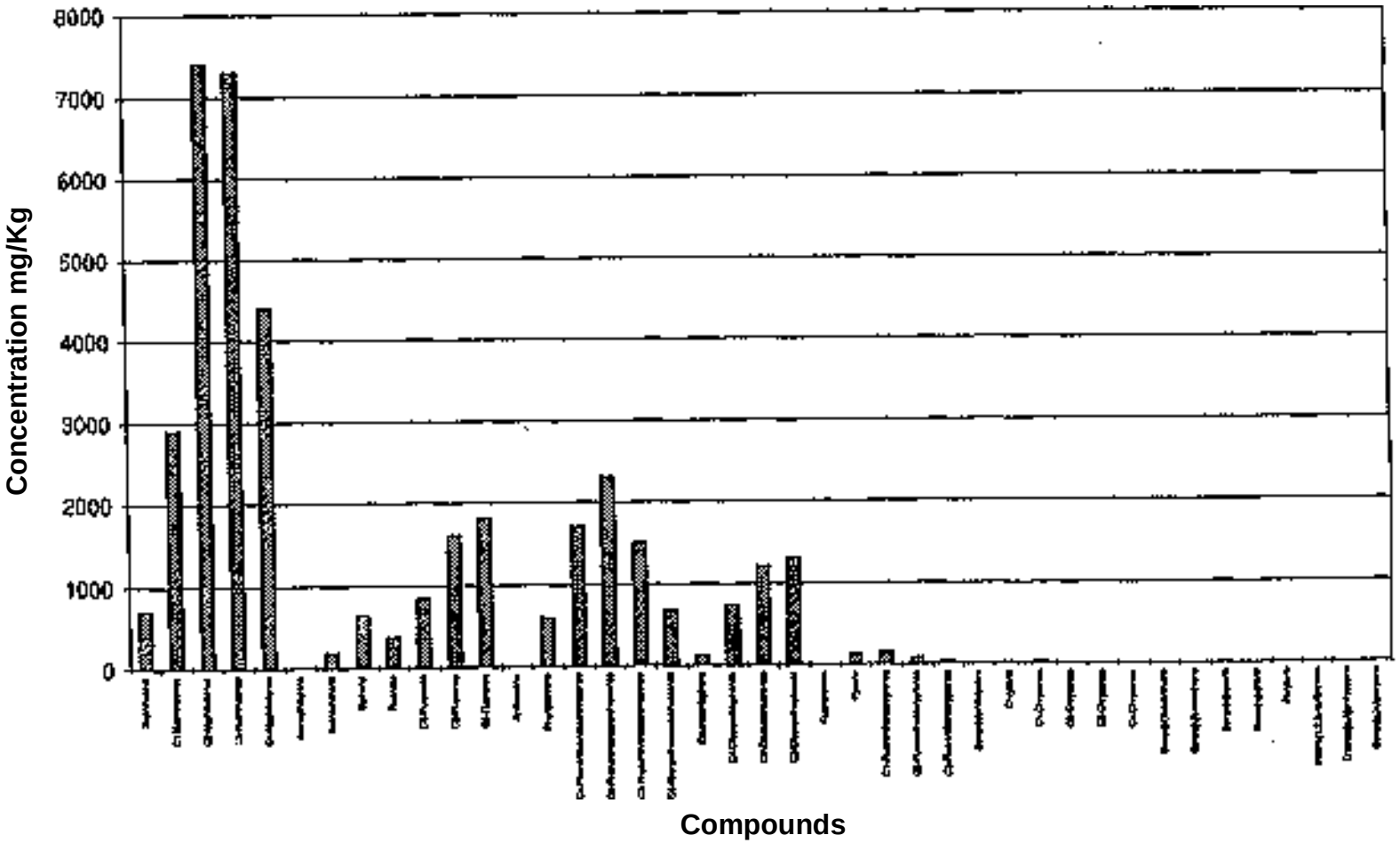
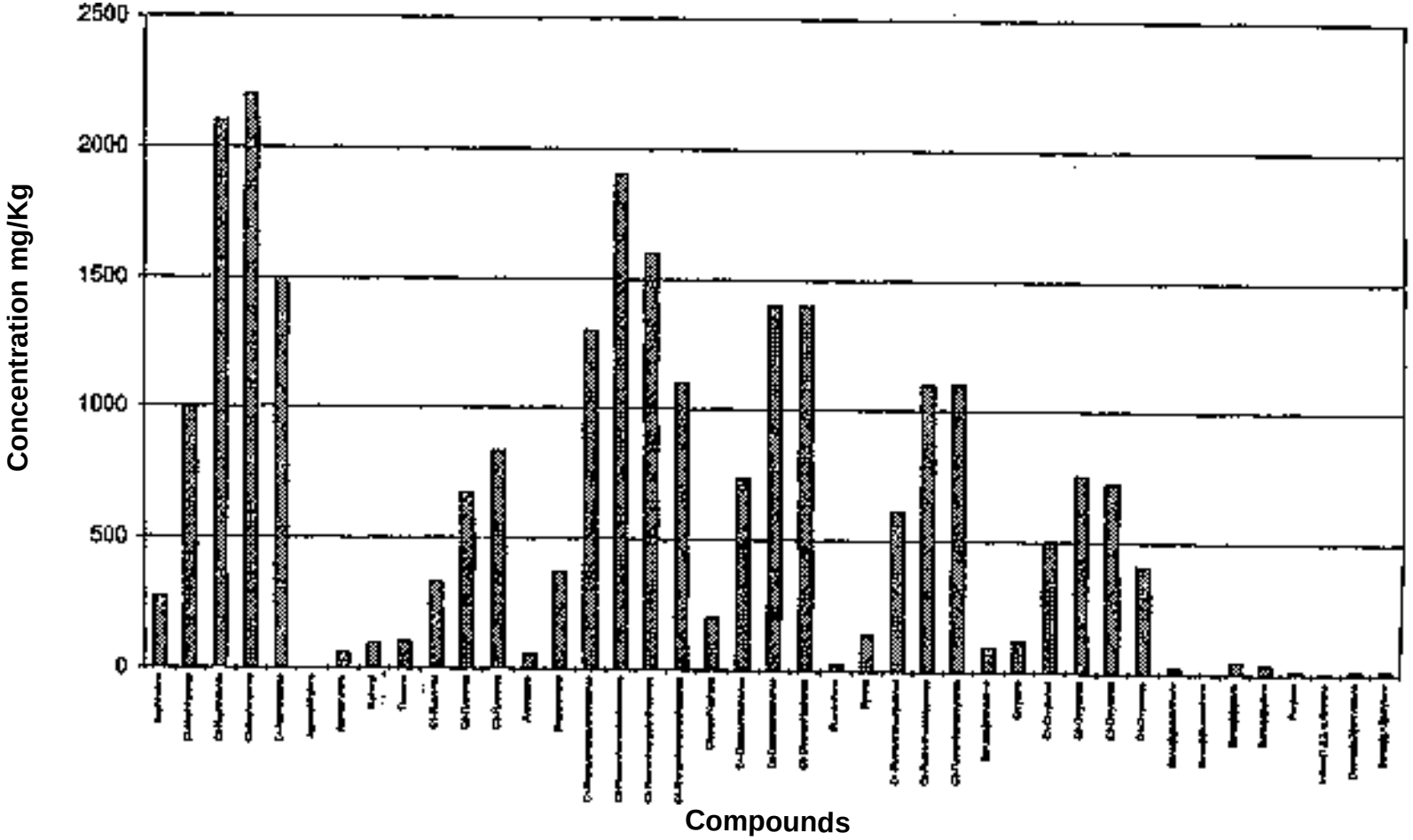


Exhibit 3-6

Analyte Histogram for *Julie N* IFO380 (BF60)

(ADL 1996)



The strong similarity between the overlapping fractions in the #2 Fuel Oil and the IFO380 is also observable in specific aromatic isomer distribution patterns. For comparison, Exhibit 3-4 presents the chromatographic profile of the #2 Fuel Oil from the recent *North Cape* incident. Clear compositional differences can be observed between the two #2 Fuel Oils, but both represent similar distillation fractions.

Exhibit 3-7 is a histogram comparison of the aromatic homologue (AH) distribution patterns for all four samples submitted. The #2 Fuel Oil is enriched with 2-ring naphthalenes and depleted of the 4- and 5-ring aromatic hydrocarbons with respect to the IFO380. The concentration of the dibenzothiophenes and phenanthrenes is relatively similar for both reference oils. The ratio of the dibenzothiophenes to phenanthrenes also is similar. Based on the AH profile data, a floating oil sample (collected 29 September, 1996) exhibits evidence of co-contamination with the #2 Fuel Oil. Weathering such as water-in-oil emulsification and the loss of the naphthalenes by dissolution and evaporation make estimating the relative contribution of one oil to the other problematic. For example, 20 to 40 percent of the floating oil sample exhibits limited water-in-oil emulsification, but no formal water content analyses were performed. Little or no evidence of co-contamination was observed in the stranded oil sample collected at the Merrill Terminal Pier.

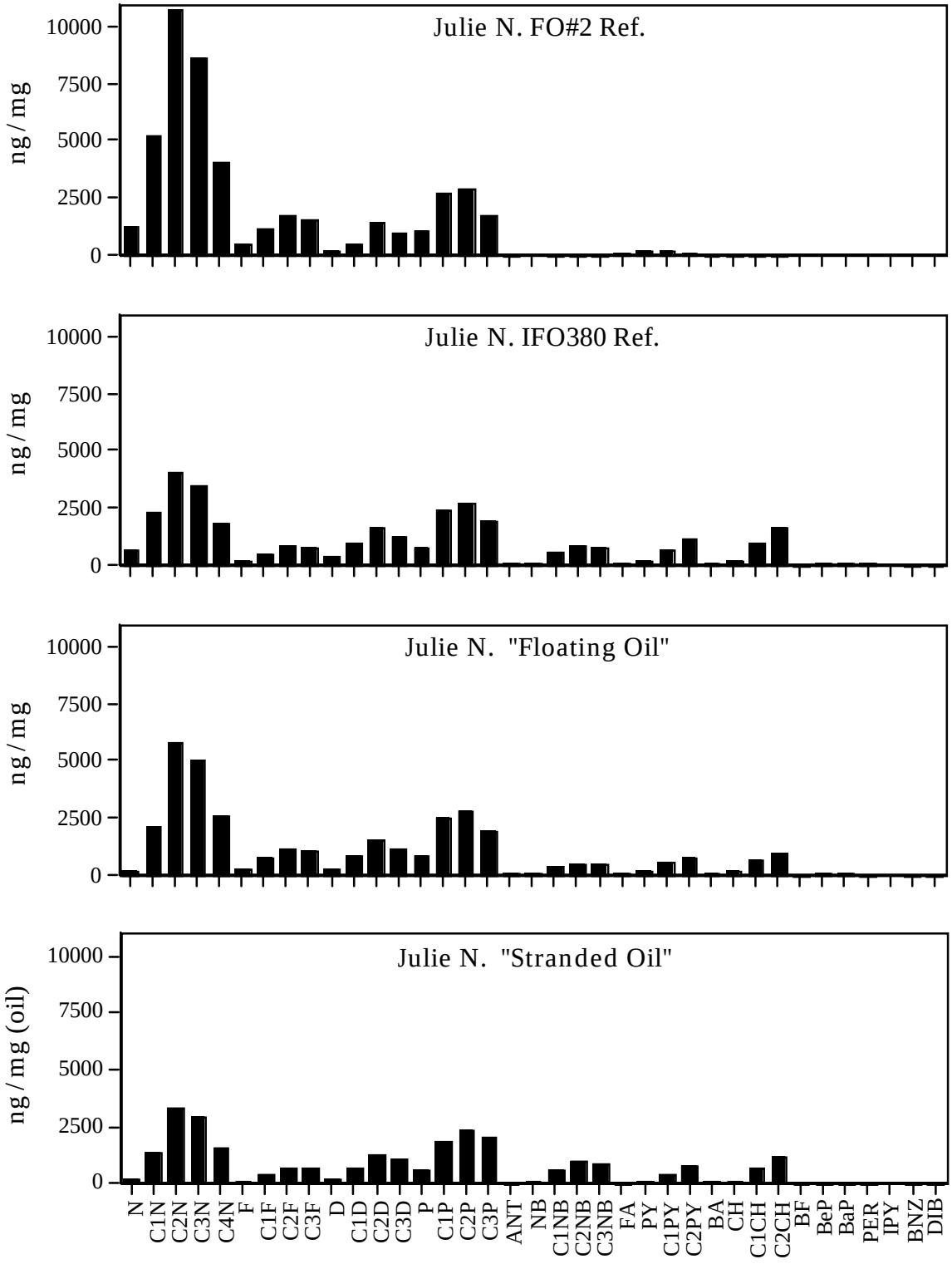
The #2 Fuel Oil and IFO380 collected from the *Julie N* appear to be within their stated classifications. A wide variability exists within both fuel oil classifications. Fuel oils are manufactured by selectively blending various petroleum fractions and byproducts from the manufacture of more desirable crude oil products such as gasoline. Heavier fuel oils include reduced crude and heavy residuals in their formulation. Fuel oil products are formulated to meet end use specifications. While different formulations may behave similarly in their intended use, once spilled in the environment, oils of different composition do not always behave in a similar or predictable manner.

Evidence derived from the two fuel samples suggest that the black visible oil is dominated by the IFO380 with only limited influence from #2 Fuel Oil. Based on the chemistry results, the spilled oil weathered as a typical Bunker C-type oil. After as little as 24 hours of weathering, a heavy black residual oil resulted which was very tacky. This residual oil readily stuck to most hydrophobic surfaces such as vegetation and man-made structures. The stranded oil was observed to be highly persistent.

The Fore River/Portland Harbor estuarine system functions as an important urban harbor in southern Maine with a long history of transporting and storing bulk quantities of petroleum products. Due to pre-existing petrogenic hydrocarbon contamination in Fore River sediments and biota, additional analytical work was conducted to distinguish petroleum contamination from the *Julie N* oil spill with pre-existing hydrocarbon contamination in environmental samples. Results from these hydrocarbon-fingerprinting studies can be found in Appendix V of this document.

Exhibit 3-7

IES/RCAT96-44



AH histogram profile comparison of the spill samples submitted for GC/MS analysis. The AH profiles in the field samples are dominated by IFO380, but evidence of co-contamination is evidenced by an enrichment of the naphthalene constituents observable in the floating oil sample.

(Based on Henry 1996)

PREASSESSMENT STUDIES CHAPTER 4

Following the *Julie N* oil spill, the natural resource trustees and responsible party (RP) initiated a series of studies designed to identify and provide a preliminary quantification of the types and extent of impacts resulting from the incident. These "preassessment studies" are intended to provide the *Julie N* Trustee Council and RP with sufficient data to make decisions regarding future NRDA actions, such as the potential need to conduct additional assessment studies and initiate restoration planning activities. The preassessment studies that were conducted after the *Julie N* spill are listed in Exhibit 4-1 and grouped according to six major types of resources:

- Marine vegetation,
- Marine communities,
- Sediment quality,
- Birds,
- Water quality, and
- Socio-economic considerations.

These categories reflect environmental or socio-economic resources identified by the natural resource trustees as being at risk from the spill. As Exhibit 4-1 shows, Appendices E through T include the preassessment study reports.

4.1 MARINE VEGETATION

The Fore River estuary supports a diverse array of intertidal marine vegetation, including four wetland species assemblages (*Spartina alterniflora*, *Spartina patens*, *Phragmites*, and mixed upper intertidal community) which generally grow in soft, unconsolidated sediment substrates such as mud, sand, and gravel. In addition, two primary species of intertidal macroalgae (*Fucus sp.* and *Ascophyllum sp.*) grow on hard surfaces. The rockweed, *Fucus sp.*, is found primarily on

pilings and attached to rocks and reefs that are scattered in shallow mudflats. Knotted wrack, *Ascophyllum sp.*, forms a dense mat over the more substantial areas of hard surface such as rock walls and bulkheads.

Both wetland and algal vegetation were oiled as a result of the *Julie N* spill. Three preassessment studies were conducted to assess the extent of marine vegetation impacts: 1) the *Julie N* Oil Spill Intertidal Vegetation Survey, 2) the Extent of Oiling of Wetlands study, and 3) the 1997 Monitoring of Oiled Wetlands study. These studies are summarized below. The entire reports resulting from these studies can be found in Appendices E and F, respectively.

Exhibit 4-1

***JULIE N* OIL SPILL PREASSESSMENT STUDIES**

Study Name	Resource Type	Principle Agency or Organization	Principle Contact (Affiliation)	Appendix for Full Study Report
Intertidal Vegetation Survey	Marine Vegetation	MDMR	Linda Mercer (MDMR)	E
Extent of Wetland Oiling	Marine Vegetation	RPI	Jaqui Michel (RPI)	F, Part 1
1997 Monitoring of Oiled Wetlands	Marine Vegetation	RPI	Jaqui Michel (RPI)	F, Part 2
Marine Finfish Survey (Otter and Beam Trawls	Marine Communities	MDMR	Linda Mercer (MDMR)	G
Marine Finfish Survey (Beach Seine)	Marine Communities	MDMR	Linda Mercer (MDMR)	H
Shellfish Tissue/Sensory Panel/Fisheries Closures	Marine Communities	MDMR	Linda Mercer (MDMR)	I
Juvenile Lobster Mortality Study	Marine Communities	MDMR	Linda Mercer (MDMR)	J
Blue Mussel Hydrocarbon Analyses	Marine Communities	MDEP	John Sowles (MDEP)	K, Part 1
Mussel and Clam Hydrocarbon Analyses	Marine Communities	MDEP	John Sowles (MDEP)	K, Part 2
Migratory Bird Forage Base Preassessment Study	Marine Communities	USFWS	Drew Major (USFWS)	L
Vertical Wall Biotic Community Diver Survey	Marine Communities	MDEP	John Sowles (MDEP)	M
Subtidal Benthic Community Diver Survey	Marine Communities	MDEP	John Sowles (MDEP)	N
Sediment Quality	Marine Sediments	MDEP	John Sowles (MDEP)	O
Surface Sediment Oiling Study	Marine Sediments	USFWS	Drew Major (USFWS)	P
Continuation of Bird Monitoring and Collection of Dead Birds	Birds	MDIFW	Richard Dressler (MIFW)	Q

Exhibit 4-1 (continued)

***JULIE N* OIL SPILL PREASSESSMENT STUDIES**

Study Name	Resource Type	Principle Agency or Organization	Principle Contact (Affiliation)	Appendix for Full Study Report
Wading Bird, Waterfowl, and Shorebird Distribution and Abundance Survey	Birds	MDIFW	Richard Dressler (MIFW)	R
Water Sampling (Batch 1 only – i.e. 10/1/96 Samples)	Water Column	BEAK	Gary Mauseth (BEAK)	S
Lost Use Valuation Report	Socio-Economic	IEc	Tim Reilly (IEc)	T

4.1.1. Macroalgal Removal

Macroalgae provides habitat structure for a host of invertebrate species. The loss of this habitat through cutting/removal of seaweed can result in ecological disturbances to these intertidal habitats. The objective of the *Julie N* Oil Spill Intertidal Vegetation Survey (Appendix E) was to determine the amount of oiled intertidal macroalgae (*Ascophyllum sp.* and *Fucus sp.*) removed during response operations. Locations of algae cutting are provided in Exhibit 4-2.

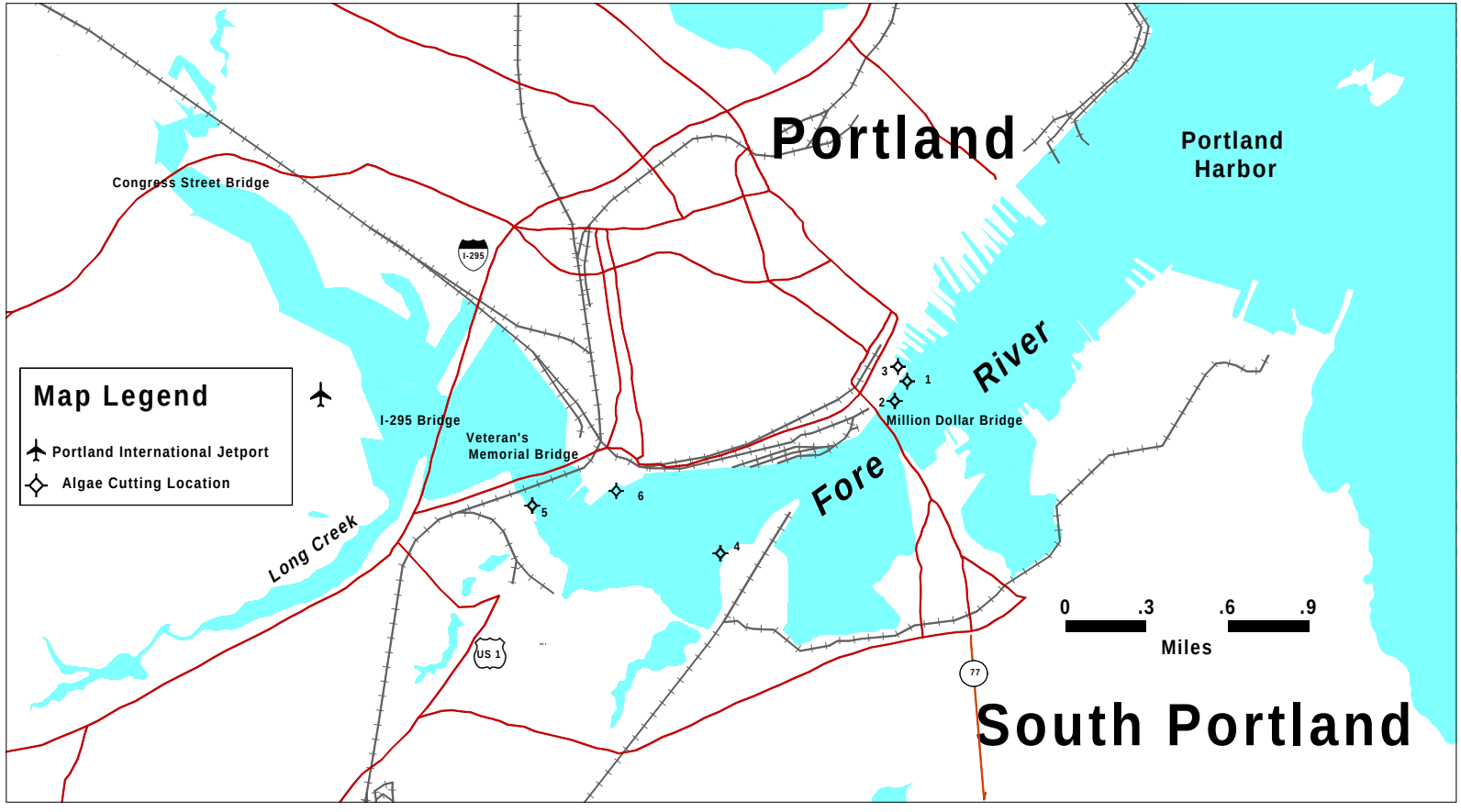
The extent of macroalgae removal was determined using two methodologies, area removed and amount removed. Along the International Ferry Terminal and near Deak's Wharf the percent of seaweed removed from measured areas was determined (Exhibit 4-3). In other areas, such as at Sprague Terminal and along a stone wall at Zone 3C, the number of ten-pound bags of algae removed was counted (Exhibit 4-3).

4.1.2. Wetlands

The Trustees conducted two wetlands studies following the *Julie N* oil spill, *Extent of Oiling of Wetlands* and *1997 Monitoring of Oiled Wetlands*. This section discusses both of these studies, which are included as Appendix F.

Exhibit 4-2

Locations of Algae Removed During Response Operations
(Based on Brocco 1996)



Use Only As A General Reference

Graphic Does Not Represent Precise Locations

Exhibit 4-3

AMOUNT OF ALGAE REMOVED DURING RESPONSE OPERATIONS: *JULIE N* OIL SPILL (DATA FROM BROCCO 1996)

Location	Primary Species Removed	Amount Removed (Square Feet)	Amount Removed (Pounds)
East of International Ferry Terminal	*Ascophyllum*	63	N/A
West of International Ferry Terminal	*Ascophyllum*	300	N/A
Deak's Wharf	*Ascophyllum*	180	N/A
Upriver from Turner's Island	Information Not Provided	600	N/A
Sprague Terminal: Steel Bulkhead/Beach Area	*Ascophyllum*	N/A	200
Stone Wall Bordering Zone 3C, Extending to the Midpoints of Zones 3C8 and 3C9.	*Ascophyllum*	N/A	140
Total Removed		**1143**	**340**

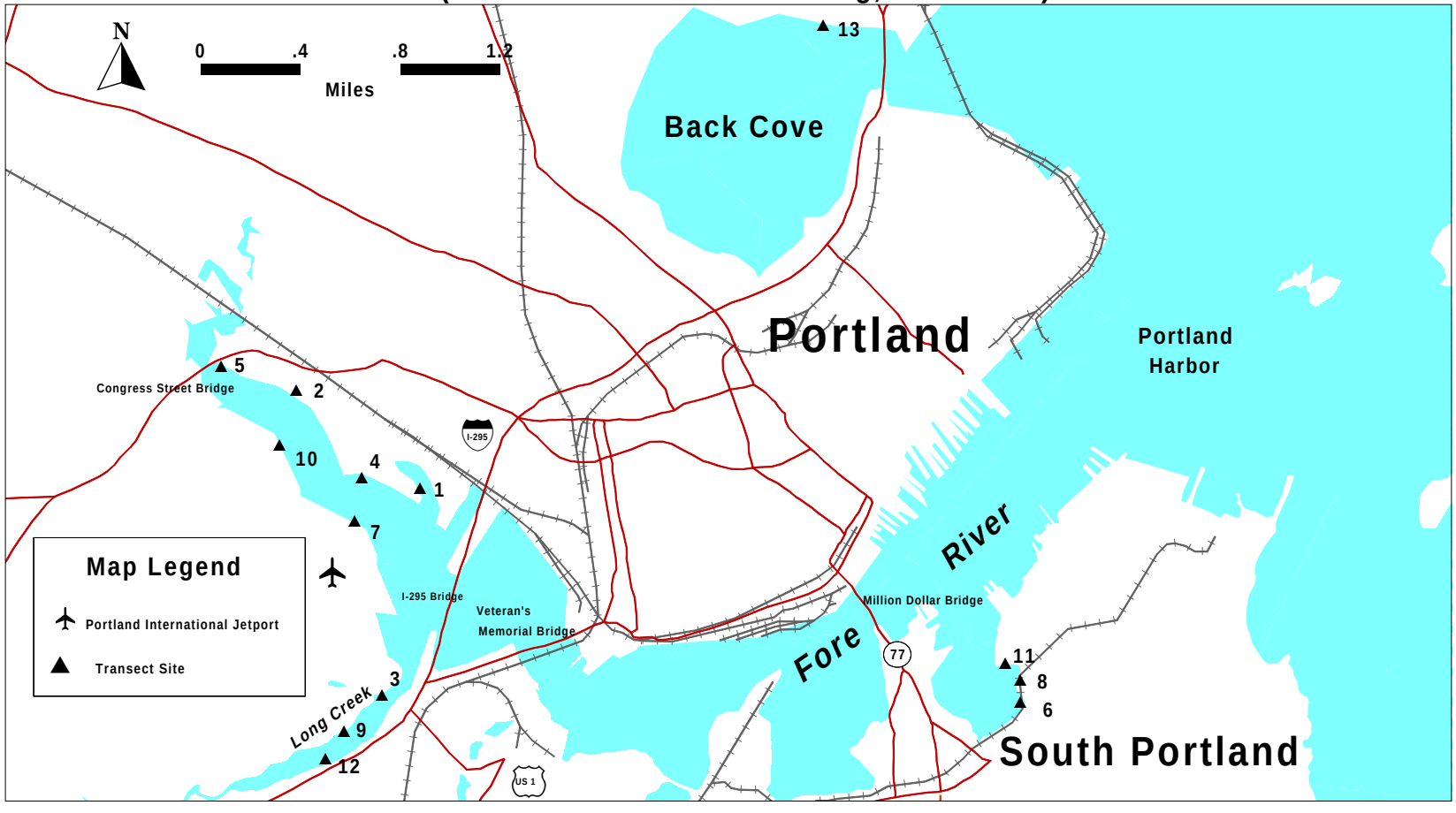
Extent of Oiling of Wetlands

A detailed analysis of the degree of wetlands oiling in the Fore River occurred through a combined aerial survey and ground-truthing approach. Detailed vertical aerial photography (1:2,400) covering most of the impacted areas was obtained on 30 September 1996. Ground-truth surveys documenting the wetland species affected, the degree of oiling on the vegetation and substrate, and the width of oiling along the shoreline were conducted from 1 to 8 October 1996. The ground-truth surveys consisted of: 1) 13 sampled permanent transects; and 2) field observations which were recorded directly onto aerial photographs. The locations of the ground-truthing stations are provided in Exhibit 4-4. These photographs and ground-truth data were used to map the aerial extent of wetland vegetation and oiling categories and generate summary statistics on the number of wetland acres affected by the spill. Wetland species/community assemblages studied included *Spartina alterniflora*, *Spartina patens*, *Phragmites*, and a mixed upper intertidal community. There were four oiling categories used in this study:

- Heavy: >67 percent oil coverage of the above-ground vegetation
- Moderate: 33-67 percent oil coverage of the above-ground vegetation
- Light: 1-33 percent oil coverage of the above-ground vegetation
- Trace: <1 percent oil coverage of the above-ground vegetation

Exhibit 4-4

Locations of Wetland Oiling Transect Sites
(Based on Research Planning, Inc. 1997a)



Use Only As A General Reference

Graphic Does Not Represent Precise Locations

Summary results of this survey can be found in Exhibit 4-5a below. A copy of the entire study report can be found in Appendix F, Part 1.

Exhibit 4-5a

SUMMARY OF THE NUMBER OF ACRES OF OILED WETLANDS BY DEGREE OF OILING CATEGORIES AND SPECIES[1] (RPI 1997a)

Species	Oiling Category	Acres	Percent of Mapped Wetlands that Were Oiled
S. alterniflora	Heavy	9.78	26.6
	Moderate	2.22	6.10
	Light	4.83	13.1
	Trace	5.87	16.0
	Total Oiled	22.70	61.7
	Total Mapped	36.79	
S. patens	Heavy	2.17	12.1
	Moderate	0.43	2.4
	Light	0.08	0.4
	Trace	0.00	0.00
	Total Oiled	2.68	14.9
	Total Mapped	17.96	
Upper Marsh Community	Heavy	0.05	2.8
	Moderate	0.00	0.00
	Light	0.18	10.6
	Trace	0.00	0.00
	Total Oiled	0.22	13.4
	Total Mapped	1.67	
Phragmites	Total Mapped	0.31	
Wetland-undifferentiated (above the Congress St. Bridge)			
	Total Mapped-unoiled	45.68	
All Wetland Species	Heavy	12.0	11.7
	Moderate	2.65	2.6
	Light	5.09	5.0
	Trace	5.87	5.7
	Total Oiled	25.61	25.0
	Total Mapped	102.41	

[1] Not all wetlands in the oiled areas were mapped

1997 Monitoring of Oiled Wetlands

To provide data on the conditions of intertidal wetlands in the Fore River one year after the *Julie N* spill, a study was conducted which repeated the field surveys of wetlands conducted in 1996. Specifically, the field work for the study included surveys of the original 13 permanent transects and foot/boat surveys of previously oiled wetlands. These surveys were conducted from 26 to 29 August, 1997. Aerial photography was conducted on 24 August 1997 (Research

Planning, Inc. 1997b); however, aerial photographs were not used to assess wetland impacts, but were collected for historical documentation purposes. A copy of the monitoring report is contained in Appendix F, Part 2.

The monitoring of the wetlands in 1997 revealed that, although most of the vegetation appeared healthy, certain areas previously affected by the *Julie N* spill showed signs of stress. For instance, the large salt marsh area at Thompson Point, which was heavily oiled in 1996, still had visual evidence of impact such as brown, dead *S. patens* on top of the pre-spill marsh scarp. In addition, spotty sheens were observed on the water surface in the creek draining the marsh and on the tidal flat surface.

The marsh vegetation between Thompson Point and the Congress Street Bridge also showed evidence of stress. In this area, there were scattered open patches in the marsh where much of the *S. alterniflora* vegetation had died and not regrown from the roots, and the broken-off dead stems from the previous year's growth were still visible.

The areas of all the dead patches observed and measured in the oil spill area are individually listed in Table 4 of the monitoring report. To illustrate the findings from both wetlands studies discussed in this section, Exhibit 4-5b lists the mean and standard deviation for stem density and stem height of *S. alterniflora* for measurements taken in 1996 and 1997, grouped by oil category and general plant height.

4.2 MARINE COMMUNITIES

A wide range of subtidal biological resources in the Fore River estuary and neighboring Casco Bay were examined for impacts from the *Julie N* oil spill. Subtidal biological resources examined included:

- Finfish,
- Shellfish,
- Hard surface vertical wall communities, and
- Marine benthic communities.

Studies involving each of these resources and respective findings are summarized in the sections below.

Exhibit 4-5b

MEAN VALUES (± 1 STANDARD DEVIATION) FOR *S. ALTERNIFLORA* STEM DENSITY AND HEIGHT, FOR 1996 AND 1997, FOR VARIOUS GROUPINGS OF VEGETATION HEIGHT AND DEGREE OF OILING (RPI 1997b)

Degree of Vegetation Oiling (# of Transects)	Mean Stem Density, in # per 1/16 m^2 ± std dev (# of counts)		Mean Stem Height, cm	
	1996	1997	1996	1997
Tall Heavy (4)	24.9±6.4 (8)	22.2±15.4(9)	134.6±21.3 (20)	141.1±7.8 (10)
Tall Moderate (2)	20.2±5.5 (4)	27.3±2.4 (6)	144.2±13.5 (10)	149.1±11.1 (8)
Tall Hvy/Mod (6)	23.3±6.3 (12)	24.3±12.0 (15)	137.8±19.4 (30)	144.7±10.0 (18)
Tall Light (3)	20.0±2.1 (6)	23.4±5.4 (9)	158.1±11.9 (15)	128.0±8.8 (20)
Tall Unoiled (1)	41.5±5.0 (2)	56.7±4.5 (3)	141.2±8.3 (5)	117.4±8.4 (5)
Short Heavy (4)	21.5±6.9 (6)	23.5±3.6 (15)	112.9±17.5 (15)	116.4±12.8 (21)
Short Moderate (2)	19.3±2.9 (6)	19.9±4.0 (7)	123.3±11.0 (10)	115.8±8.6 (10)
Short Hvy/Mod (6)	20.4±5.2 (12)	22.3±4.0 (22)	117.0±15.9 (25)	116.2±11.5 (31)
Short Light (2)	16.0±0.8 (4)	25.0±9.7 (6)	125.4±7.5 (10)	105.4±10.3 (20)
Unoiled Short (1)	20.5±0.7 (2)	16.3±2.9 (3)	108.6±5.7 (5)	108.8±6.8 (5)
All Heavy (6)	23.4±6.6 (14)	23.0±9.5 (24)	N/A	N/A
All Moderate (3)	19.7±3.9 (10)	23.3±5.1 (13)	N/A	N/A
Heavy/Mod (9)	21.9±5.8 (24)	23.1±8.1 (37)	N/A	N/A
All Light (3)	18.4±2.6 (10)	24.1±7.1 (15)	N/A	N/A
Unoiled (1)	31.0±12.4 (4)	36.5±22.3 (6)	N/A	N/A

4.2.1. Finfish

The Fore River provides habitat for a number of marine and estuarine species of fish such as Atlantic silversides, Atlantic herring, and bluefish (Normandeau Associates, Inc. 1989). Although no fish kills were observed following the oil spill, at least one species, the mummichog (*Fundulus heteroclitus*), was observed in the marsh swimming in oiled waters (MDMR 1996a). This is an important forage species for birds and other predators.

Two studies were conducted to determine impacts from the spill to finfish within the Fore River, the most heavily impacted area. The first marine finfish survey was conducted by MDMR and a representative of the RP on October 7-8, 1996 (Appendix G). The survey was restricted to the heaviest area of oiling between the Million Dollar Bridge and the I-295 Bridge. The presence of lobster traps in the area below the Million Dollar Bridge prevented trawling in that part of the Fore River. Trawl tows were made in the upper Fore River using a 10-foot otter trawl (stretched mesh about 1 inch with no liner) and a 4-foot beam trawl (stretched mesh approximately 1/4 inch). Four tows of 10 minutes duration were made on both October 7 and 8. No fish but several

dozen green crabs (*Carcinus maenus*) and sand shrimp (*Crangon septimspinosa*) were collected. No evidence of oil was present on any of the decapods or on the sampling gear. Tow locations for October 7, 1996 are listed below and mapped in Exhibit 4-6.

Tow #1: Started adjacent to Merrill Terminal along south side of channel, towed east.

Tow #2: Started at Route 1 Bridge, towed north in channel.

Tow #3: Started about 0.5 kilometers south of I-295 bridge, towed west in channel.

Tow #4: Started about midway between Route 1 Bridge and I-295 Bridge, towed southeast in channel.

The four tows made on October 8th by MDMR also were about 10 minutes each in duration (MDMR 1996a). A beam trawl was used in the upper Fore River between the I-295 Bridge and Congress Street Bridge. Again, no fish were collected in any tows. Several dozen green crabs and sand shrimp were collected and no evidence of any oil or residue was seen on the decapods, the collected shell hash, the muddy substrate, or on the sampling gear. Trawl site locations for October 8, 1996 are mapped in Exhibit 4-7 and listed below:

Tow # 1: Started adjacent to the mouth of Clark Brook and towed northwest on the western side of the estuary.

Tow #2: Started 100 meters south of Clark Brook outlet, towed east in channel

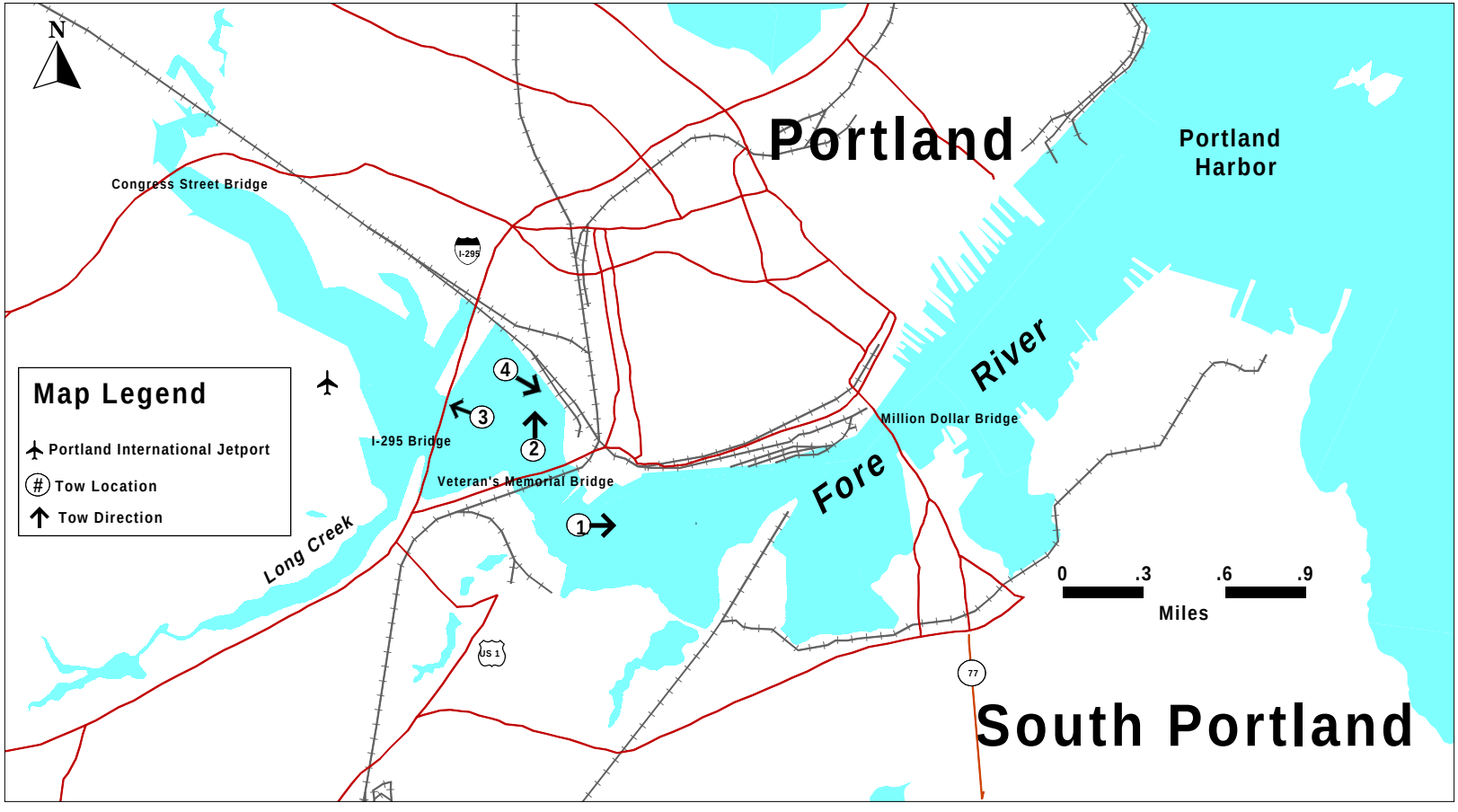
Tow #3: Started about 0.5 kilometers south of Clark Brook mouth, towed southeast in channel immediately adjacent to heavily oiled marsh on eastern shore.

Tow #4: Started about midway between Congress Street Bridge and I-295 Bridge, towed north of channel.

The resulting lack of fish collected from these eight tows prompted a recommendation from the Friends of Casco Bay to conduct a subsequent finfish survey using a beach seine (Appendix H). Normandeau Associates (NAI), on behalf of the RP, conducted beach seine sampling in Portland Harbor and Back Cove on November 8, 1996 (MDMR 1996b). Duplicate seine hauls were collected at four stations: upper fore River (Station 1), near Thompson Point (Station 2) on the east side of the I-295 Bridge (Station 3), and just inside Back Cove (Station 4). Specific station locations can be found in Exhibit 4-8. Collections were made at or near low-water slack tide using a 30.5 meters x 2.4 meters bag seine with a 4.3 meters x 2.4 meters nylon bag with 1.3 centimeter stretch mesh, and 13.0 meters x 2.4 wings with 2.5 centimeter stretch mesh. Fish collected were identified to the lowest practical taxon (usually species) and enumerated. A total of 84 fish were collected during this effort: 8 fish at Station 1; 10 at Station 2; 13 at Station 3; and 53 at Station 4. Most were Atlantic silverside. Low numbers of rainbow smelt, alewife, nine-spined stickleback, mummichog, grubby sculpin, and winter flounder were also collected.

Exhibit 4-6

October 7, 1996, Marine Finfish Survey Tow Locations Using an Otter Trawl and a Beam Trawl
(Based on MDMR 1996a)

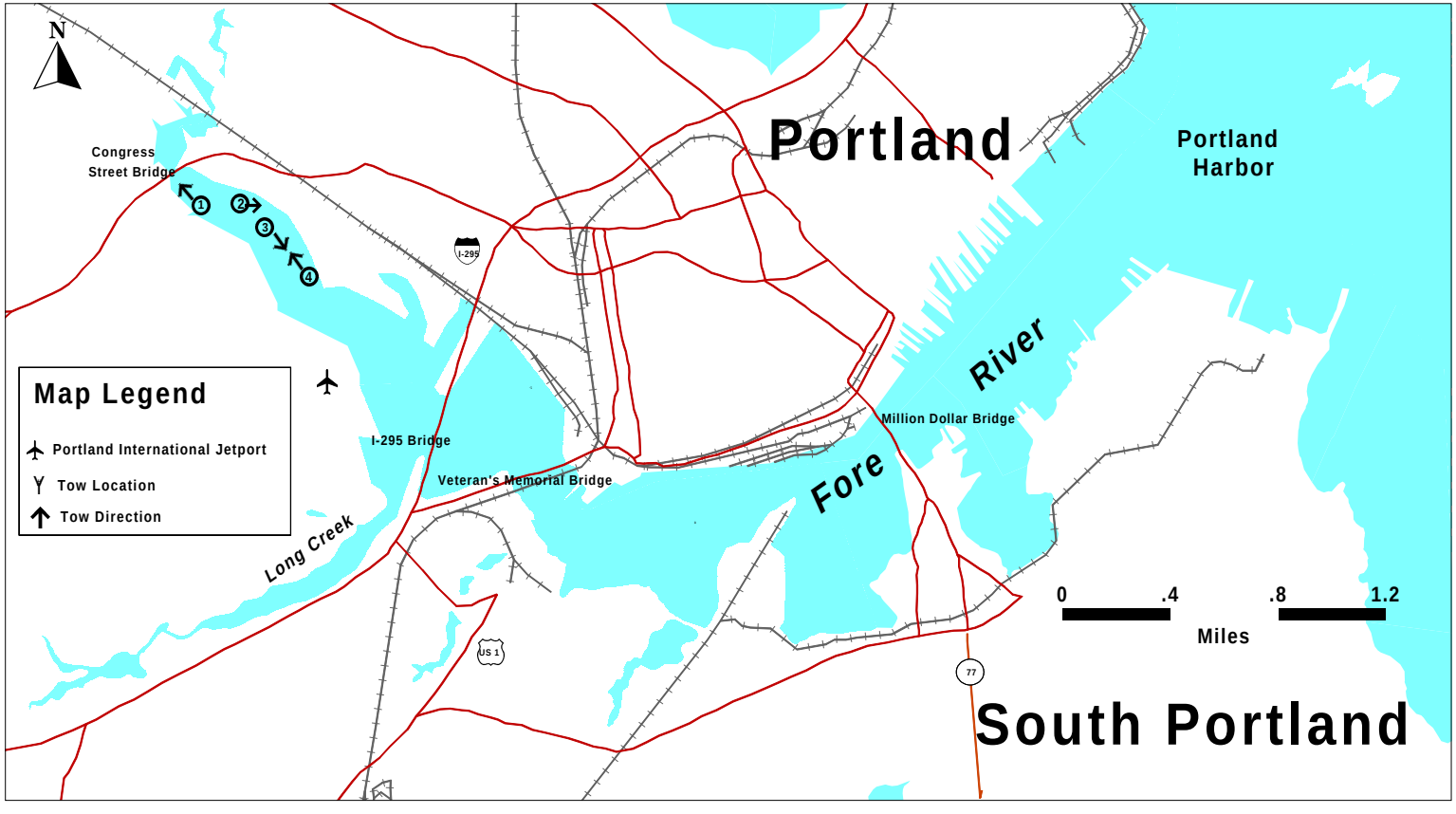


Use Only As A General Reference

Graphic Does Not Represent Precise Locations

Exhibit 4-7

October 8, 1996, Marine Finfish Survey Locations Using an Otter Trawl and a Beam Trawl
(Based on MDMR 1996a)

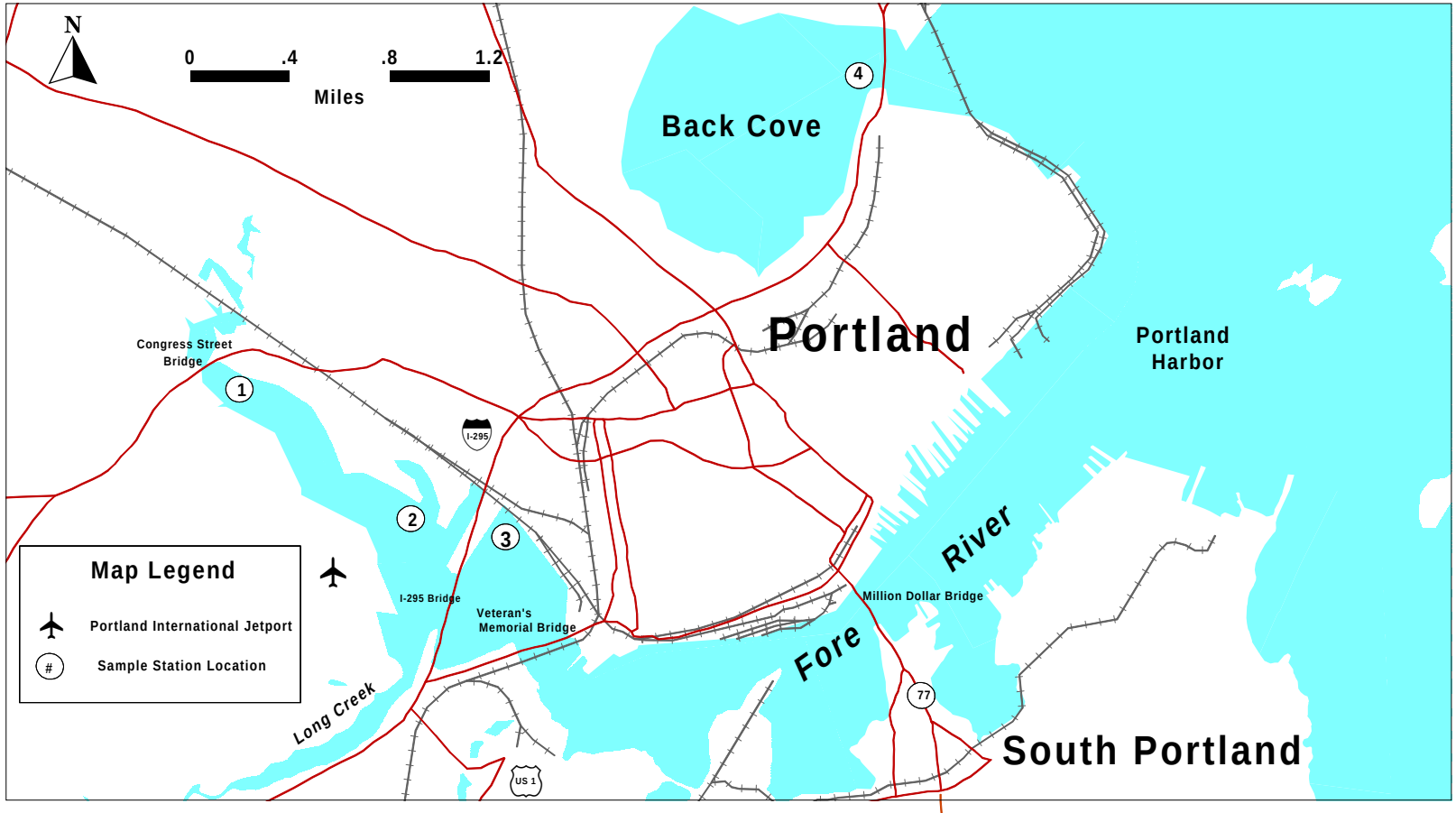


Use Only As A General Reference

Graphic Does Not Represent Precise Locations

Exhibit 4-8

November 8, 1996, Marine Finfish Survey Locations Using a Beach Seine (Based on MDMR 1996b)



Use Only As A General Reference

Graphic Does Not Represent Precise Locations

Numbers of fish at the reference station (Station 4) were substantially higher than the number of fish collected in the Fore River, due to the presence of a school of fish. Specific numbers of fish and associated species netted are presented in a summary table at the end of Appendix H. No discussion of oil spill related injuries were presented in this report.

4.2.2. Shellfish

Several preassessment studies addressing shellfish impacts were conducted following the *Julie N* oil spill. A number of these studies were conducted to support fishery closure evaluation activities, while others sought to determine the ecological impacts stemming from the spill. In this section, monitoring data are presented for lobster, scallop, sea urchin, blue mussel, soft-shelled clam, gastropod, and other macroinvertebrate populations.

4.2.2.1. Use of Sensory and Chemical Analysis in Fishery Closure Evaluations

As part of the effort to evaluate the effects of the *Julie N* oil spill on fisheries in Casco Bay, samples of lobsters, sea urchins, scallops, blue mussels and soft-shelled clams were collected between 4 and 6 October 1996. A second collection of lobsters was made on October 28 and 29. Sensory evaluation and chemical analyses of these samples were used to determine actions concerning closures. Fishery closures were based on observed and projected movements of oil and on the likelihood of impacts when species distributions and fishing methods were considered. A detailed discussion of fisheries closures can be found in Section 4.6 (Socioeconomic Impacts) of this report.

Sensory evaluation for the detection of petroleum odors was carried out as the initial step in the protocol developed to evaluate fishery closures. The full protocol for this sensory evaluation can be found in Attachment 1 of the shellfish fishery sensory and chemical analyses report in Appendix I. In summary, the sensory evaluation was conducted by a panel of five United States Department of Commerce evaluators who had received training in the detection of oil. Some of the panel members were unfamiliar with several of the species and product forms. As part of their orientation, evaluators were given samples from outside the area potentially influenced by the spill so that they could familiarize themselves with the species and observe the usual odors associated with the product. When lobsters, sea urchins, and scallops were found to pass the sensory evaluations, samples at selected stations were analyzed for oil related compounds by GC/MS. Samples of blue mussels and soft-shelled clams were subjected to sensory evaluations but not analyzed chemically. The initial protocol for fishery reopening was finalized on October 3, 1996. Following the revision of rule #5000 on October 19, 1996, a modified protocol was used in which only sensory evaluation was performed. This protocol was applied to lobsters from the October 28 and 29 collection.

The sensory panel found the samples acceptable according to the sensory evaluation protocol developed. Failure of an individual station was based on the composite score for the station. This composite score included all possible detections, of which three-fifths would have to fail in order for the station to fail. On this basis no station failed the sensory evaluation, though oil was detected in some individual tests (MDMR 1996c).

Based on chemical analyses, all samples were found to be in acceptable ranges; however, lobster samples collected in sampling zones 4, 5 and 6 (Exhibit 4-9) were elevated (Exhibit 4-11) over background levels (MDMR 1996c). Source allocation of oil in samples (i.e. oil fingerprinting) was conducted by the RP to identify the original sources of oil (Appendix V). Summary findings from these studies are presented in appropriate sections in this report.

Sensory evaluation and analytical data results for specific shellfish species are presented below.

4.2.2.2. Lobsters

Lobster (*Homarus americanus*) samples were collected on October 4, 5, 28 and 29, 1996. Collection sites are shown in Exhibit 4-9 (MDMR 1996c). Samples collected on October 4 and 5 were from fishermen's traps which had been in place since the date of the spill. With the exception of station 6A, water depths were 30 feet or greater. In several cases the full complement of samples that had been planned could not be collected, either because there were no traps in the area or because traps were empty. As a result, a sufficient number of lobsters was not available for chemical analysis at some stations, specifically at sample sites 6A and 6B. For the initial tests, sensory evaluation was performed at these stations but lobsters from 6A and 6B were pooled to meet the number of lobsters required by the protocol. On October 28 and 29 lobsters for sensory evaluation were collected from fishermen's traps as before. There also was an attempt to have divers collect lobsters that were not trapped by hand. Because of poor subsurface visibility, this approach was successful only at four stations. Lobsters were collected by divers in the vicinity of stations 3A, 4C, 4D, and 5D. Because of the difficulty of obtaining samples, further attempts using this method were abandoned.

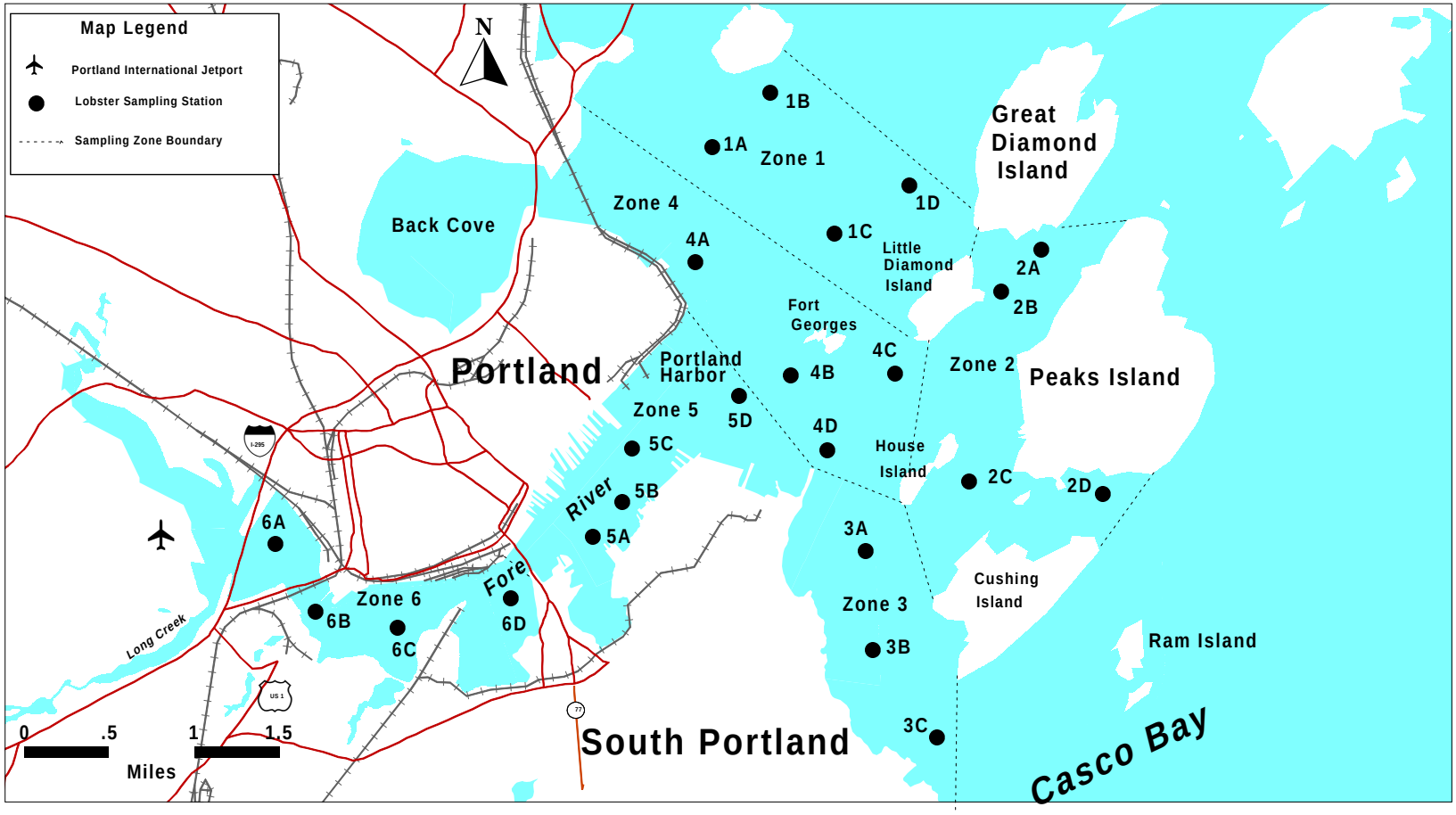
Lobsters were evaluated in three states; the raw (whole) form, the cooked head, and the cooked tail (MDMR 1996c). There were three lobster samples in three states or product forms for each station. Each of the five panel members made nine evaluations. Thus, there was a total of 45 possible detections at each station.

Results of the sensory evaluation are provided in Exhibit 4-10. Two general observations can be made. First, there appeared to be different levels of sensitivity among the panel members when evaluating lobsters. On both occasions when the panels were formed, a single panel member detected oil at a much higher frequency than that of other members. Though the data are limited, this did not appear to be the case with the other seafood products which were evaluated. Second, it appears that there was a higher instance of tainting in the Fore River as compared to the remainder of Portland Harbor. Detections in lobsters were particularly high in zone six in both early and late October (MDMR 1996c).

Exhibit 4-9

Lobster Sampling Stations

(Based on MDMR 1996c)



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Graphic Does Not Represent Precise Locations

Exhibit 4-10

***JULIE N* SENSORY EVALUATION AND ANALYTICAL RESULTS: LOBSTERS (BASED ON MDMR 1996c)**

Station	Number of Sensory Evaluation Hits (per 45 tests [a]): 4-6 October Samples	Number of Sensory Evaluation Hits (per 45 tests [a]): 28-29 October Samples	Total PAH (ppb) / Carcinogenic Totals (ppb): Replicate Sample 1: 4-6 October Samples	Total PAH (ppb) / Carcinogenic Totals (ppb) Relative to Benzo(a)pyrene: Replicate Sample 2: 4-6 October Samples	Average PAH Concentration (ppb) / Average Carcinogenic Total (ppb) Relative to Benzo(a)pyrene
1A	0		220 / 0.74	150 / 0.084	185 / 0.412
1B	0				
1C	0		100 / 0.3	100 / 0.31	100 / 0.305
1D	3				
2A	3				
2B	1		86 / 0.77	50 / 0.28	68 / 0.525
2C	3		9.3 / 0	52 / 1.4	30.65 / 0.7
2D	1				
3A	0	0 (per 30 tests)	18 / 0	29 / 0	23.5 / 0
3B	1		85 / 1.8	68 / 0.57	76.5 / 1.185
3C	1		120 / 0.23	70 / 0.72	95 / 0.475
4A	6	4	100 / 0	170 / 0.68	135 / 0.34
4B	1	1	2300 / 35 [b]	140 / 0.6	1220 / 17.8 [b]
4C	1	3 (per 90 tests)	110 / 0.066	64 / 0.16	87 / 0.113
4D	0	1 (per 90 tests)	120 / 0.45	84 / 0.5	102 / 0.475
5A	5	3	3400 / 28 [b]	1600 / 3.9	2500 / 15.95
5B	4	0	810 / 2.7	2300 / 41 [b]	1555 / 21.85 [b]
5C	3	3	420 / 1	170 / 0.5	295 / 0.75
5D	2	4 (per 60 tests)	380 / 1.8	1600 / 26 [b]	990 / 13.9
6A	3 (per 15 tests)	16 (per 105 tests)			
6B	4 (per 30 tests)				
6C	8	11	1600 / 3.4	1700 / 2.1	1650 / 2.75
6D	4	4	2000 / 1.7	2200 / 17 [b]	2100 / 9.35
X		0 (per 15 tests)			
2X		1 (per 15 tests)			
3X		2 (per 15 tests)			

[a] Unless otherwise indicated

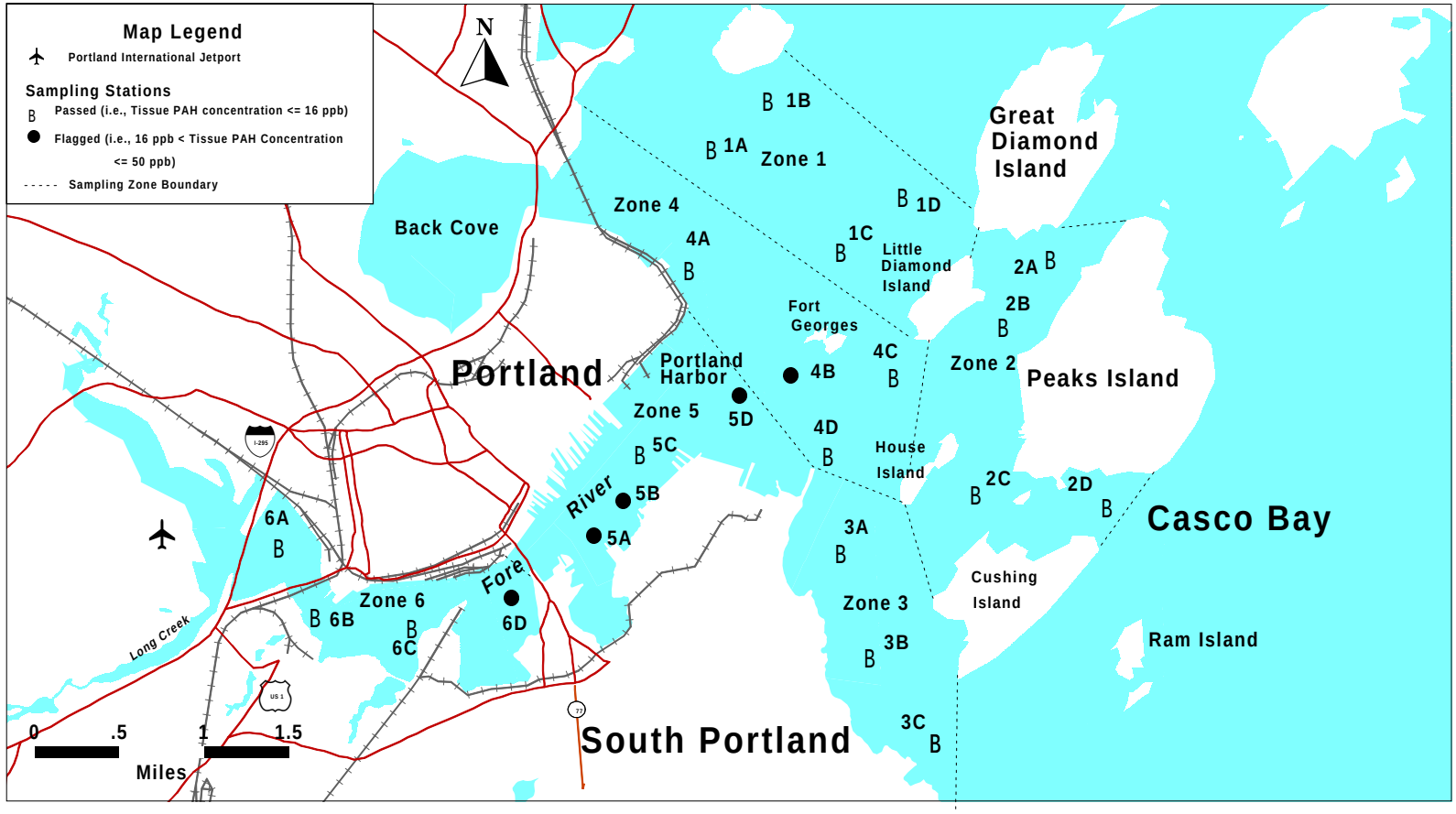
[b] Flagged carcinogenic PAH concentrations: i.e. in the 16 ppb - 50 ppb range.

Results from chemical analyses of lobster samples can also be found in Exhibit 4-10. Sampling stations where at least one lobster sample was found to have carcinogenic PAH concentrations greater than 16 ppb but not exceeding 50 ppb are identified in Exhibit 4-11. According to recent oil spill literature, the action level for carcinogenic PAHs for human consumption of lobster is 16 ppb based on a 30 year exposure period (Kemp 1998).[1] An assessment of the possible source(s) of PAHs (e.g., pyrogenic versus petrogenic PAHs) was conducted by Arthur D. Little, Inc. (ADL) (see Attachment 9 to the shellfish fishery sensory and chemical analyses report in Appendix I and Appendix V). Based on their analyses, ADL concluded that carcinogenic PAHs from the *Julie N* may have contributed to elevated levels found in samples collected from stations 5A and 6D. The chemical analyses also indicated that a portion of PAH levels in lobster tissue can be attributed to sources other than the *Julie N* oil spill. None of the samples collected for analyses were from zones 6A or 6B.

[1] The assumed lobster consumption rate used to calculate this action level is approximately a one pound lobster per week.

Exhibit 4-11

Total PAH Tissue Burdens in Lobster Samples Collected October 4 through 5, 1996 (Based on MDMR 1996c)



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ADL performed additional chemical fingerprinting analysis of the lobster samples by comparing PAH distributions, source ratio and double ratio plot methods. Petroleum residues contain ratios of alkyl dibenzathiophenes to alkyl phenanthrenes (i.e. C2D/C2P and C3D/C3P) which are resistant to environmental factors, and correlate well with specific petroleum sources. Plotting these ratios graphically demonstrates different sources of petroleum residues in potentially complex source mixtures. Petroleum residues on the Fore River samples are a mixture of PAHs from petroleum sources (termed petrogenic), combustion sources (termed pyrogenic) or biogenic processes. Petrogenic sources typically include 2- to 4-ring PAHs (excluding acenaphthylene and anthracene) with a full suite of alkyl PAHs. Pyrogenic sources include the 4- to 6-ring PAHs (including acenaphthylene. phenanthrene and anthracene) and have only trace levels of alkyl PAHs. The primary biogenic PAH is perylene, which is formed during the diagenesis of sediments.

The majority of the double source ratio plots for the lobster tails fall either within or very near the ellipses for *Julie N* oil, as shown in Figure 3 in Appendix V. The conservative approach for source allocation used in this study indicates the petrogenic PAH in these samples is likely from *Julie N* oil (i.e., most of these lobsters were exposed to oil consistent with *Julie N* oil). Of the samples plotting within the ellipses the petrogenic *Julie N* oil allocation ranges from 35 percent to 83 percent, with most of the samples ranging from 70 to 80 percent. Overall, these samples contain a wide range of total PAH concentrations (from 50 to 3500 ng/g). Three of the samples, II C 005, III B 004, and VB-1035-005, have a high proportion of pyrogenic PAHs relative to the other samples, indicating that *Julie N* oil is not the primary source of PAHs in these samples.

Lobster tails with double source ratio plots outside the ellipses fall into three categories: to the lower left (similar to the sediments), directly above, and too low to detect. For lobster tails plotting in the same area as the sediments, most have non-petrogenic PAHs ranging from 40 to 50 percent, and low total PAH concentrations, 9 to 120 ng/g. However, two samples, IVB-1005-004 and VD-1005-005, have high non-petrogenic allocations of approximately 75 percent, with substantially higher total PAH concentrations (1600-2000 ng/g). A more detailed evaluation of these two samples reveal that the PAH distribution patterns correspond to weathered creosote signatures, suggesting that the lobsters may have been collected near sediments contaminated with creosote or near pilings treated with creosote. Figure 4 (Appendix V) provides an example of a slightly weathered pyrogenic creosote signature. The lobster PAH distributions for the two samples are shown in Figures 5 and 6 (Appendix V) for comparison, and are similar but have a more weathered composition, (i.e. showing some additional depletion of naphthalenes, fluorenes, and phenanthrenes).

Lobster samples with double ratio plots directly above the ellipses, IVC-1005-004, IVC-1005-005 and IVD-1005-005, have low level total PAH concentrations and are likely not *Julie N* oil related. Three samples have residues of dibenzothiophenes and phenanthrenes that are too low to plot successfully using the double source ratio (IIC004, IIIA004, and IIIA005). Total PAH concentrations for these samples are less than 30 ng/g and are allocated as non-*Julie N* petrogenic or other petroleum sources.

Since the data from the 1994 survey of contaminants found in the Fore River in Portland Maine are restricted primarily to priority pollutant PAHs, a complete comparison of PAH allocations, as well as double ratio source plots are not possible. However, data from 1994 lobsters and the 1996 *Julie N* lobster samples can be normalized to total priority pollutant PAH on a dry weight basis, and compared (Figure 7, Appendix V). The average total priority pollutant PAH for the 1994 Portland lobsters is higher than the average for the lobsters collected after the *Julie N* oil spill. This indicates that the lobsters from the Portland harbor area contain a high "background" body burden of both petrogenic and pyrogenic PAHs and that the *Julie N* oil probably accounted for an incremental addition to overall PAHs in the lobsters impacted by the spill (ADL 1997).

In addition to lobster samples collected and analyzed in support of fishery closure evaluations, MDMR conducted a study to determine the impact of the *Julie N* oil spill on juvenile lobsters in the Fore River. The Juvenile Lobster Mortality Study (Appendix J) was conducted to identify potential juvenile lobster habitat (e.g. cobble bottom) in numerous locations throughout the Fore River estuary (MDMR 1996d). Sites were identified by aerial photography as being potential habitat and were subsequently ground-truthed. These sites included Fish Point/Munjoy Hill; the inner harbor just north of the Million Dollar Bridge (on the Portland side); Cape Station CMP facility; and the public boat ramp. Two ground-truth surveys were conducted for this study: the first was conducted on October 11 by Dr. Richard Wahle (Bigelow Laboratory for Ocean Sciences); the second was conducted on October 25 by Peter Thayer. High winds prior to both surveys increased water turbidity, making it difficult to see anything below the low tide mark. Though several potential juvenile lobster habitats were identified, no lobsters were found during either survey.

4.2.2.3. Scallops

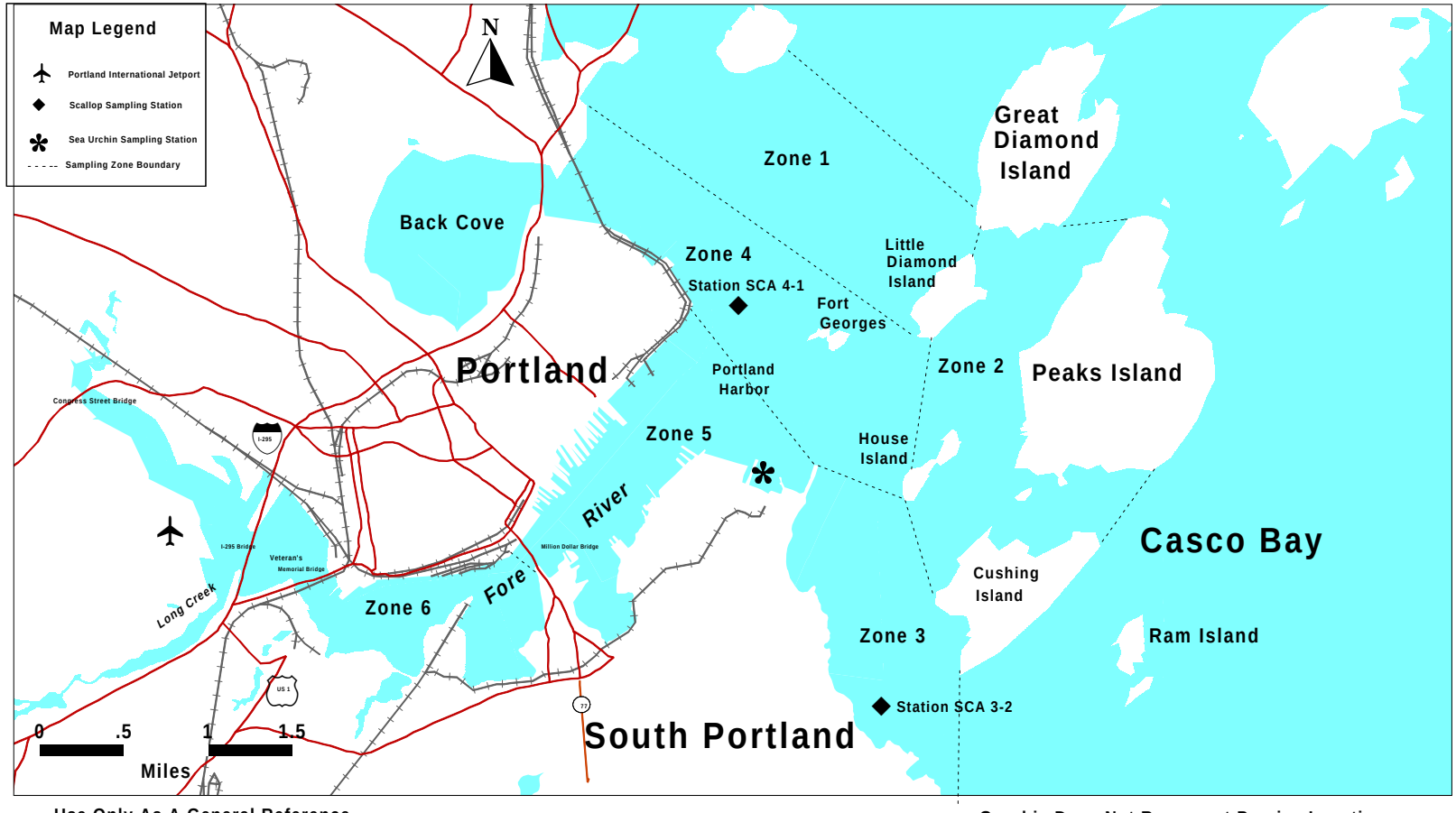
Scallops (*Placopecten magellicus*) samples were collected by divers at two locations. The first location was between Fort Gorges and the Eastern Promenade, Portland. The second was along the Cape Elizabeth shore as shown in Exhibit 4-12 (MDMR 1996c).

As part of the fishery closure evaluation, the sensory panel tested scallops in four forms: whole organism; organism with one valve removed; raw meat; and cooked meat. This was done for five samples from each of the two stations. Each of the five panel members made 20 evaluations which resulted in a total of 100 possible detection tests at each station. Exhibit 4-13 presents the results of the sensory and analytical tests. These sensory hits and PAH levels are below the level of concern for human consumption of shellfish. In a sensory evaluation, two hits out of 100 do not represent a level of concern, and there is errant variability in the tests such that two to five false-positive samples are acceptable in the context of protocol for opening fisheries. Appendix I contains the full set of data from this study.

A double plot ratio oil fingerprinting analysis conducted on scallops by ADL (1997) indicates that PAH contamination came from a *Julie N* oil source (see Figure 11, Appendix V).

Exhibit 4-12

Scallop and Sea Urchin Sampling Stations
(Based on MDMR 1996c)



Use Only As A General Reference

Graphic Does Not Represent Precise Locations

Exhibit 4-13

***JULIE N* SENSORY EVALUATION AND ANALYTICAL RESULTS: SCALLOPS (BASED ON MDMR 1996c)**

Station	Number of Sensory Evaluation Hits (per 100 tests): 5 October Samples	Total PAH (ppb) 5 October Sample	Carcinogenic Totals (ppb) Relative to Benzo(a)pyrene 5 October Sample
SCA 3-2	2	560	1.3
SCA 4-1	0	1000	1.7

4.2.2.4. Sea Urchins

Sea urchin (*Strongylocentrotus drobachiensis*) samples were collected by divers on October 5, 1996 at a single location near the Spring Point Marina (South Portland) in Zone 5 (see Exhibit 4-12 for approximate sampling location). Attempts to obtain sea urchins from other locations in the area were unsuccessful. This was due to the apparently small numbers of urchins in the vicinity of Portland Harbor.

Sea urchins were evaluated by the sensory panel in the raw form. Whole organisms were evaluated, followed by an evaluation of the raw roe. There were five samples in two states from the sample station. Each of the five panel members made ten evaluations. This gave a total of 50 possible detections for that station. No oil was detected by the sensory panel in any of these 50 evaluations. Chemical analysis of a sea urchin sample by GC/MS yielded a 1200 ppb total PAH concentration; and a 0.71 ppb total carcinogenic PAH concentration relative to Benzo(a)pyrene (MDMR 1996c). Appendix I contains all results from this study.

A double plot ratio oil fingerprinting analysis conducted on sea urchins by ADL (1997) indicates that the PAH contamination profile falls just outside the *Julie N* oil source ellipses (see Figure 11, Appendix V). The PAH distribution patterns are more heavily influenced by pyrogenic PAH (ADL 1997).

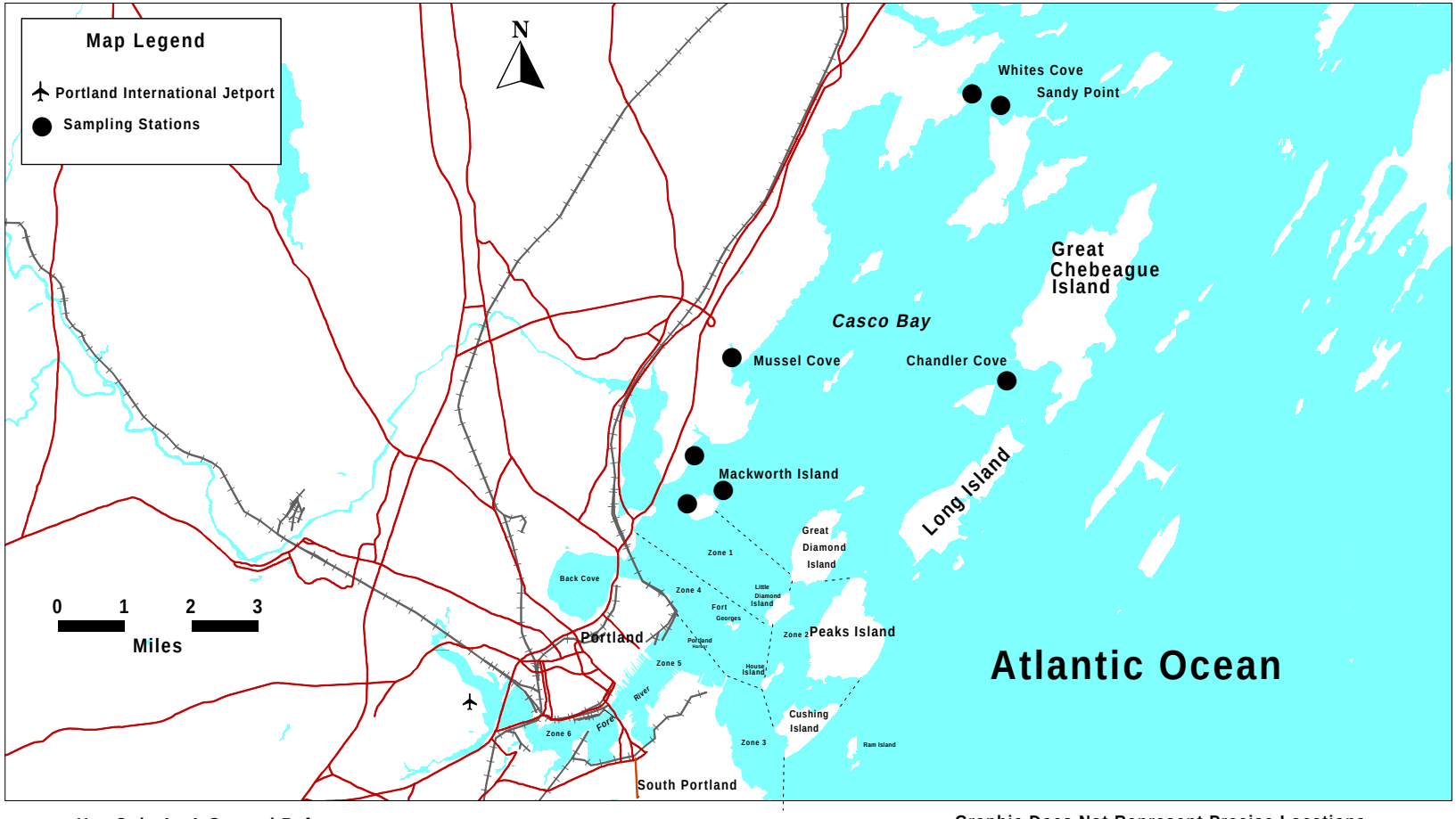
4.2.2.5. Soft-shelled Clams and Mussels

Total PAH concentrations for clams and mussels were the highest found of all the marine animal tissues (ADL 1997). Three studies were conducted to determine hydrocarbon burdens in soft-shelled clams (*Mya arenaria*) and blue mussels (*Mytilus edulis*) following the *Julie N* oil spill. The first study was a component of the MDMR fishery closure evaluation test series (Appendix I), involving sensory panel analyses of clams and mussels collected within the western portion of Casco Bay (MDMR 1996c). In this study clams and mussels were subjected to sensory, but not chemical evaluation. The second effort was the MDEP-directed Blue Mussel Hydrocarbon Analyses preassessment study (Appendix K, Part 1), which identified hydrocarbon body burdens in Fore River mussels (MDEP 1996b). A third study, the USFWS-directed Migratory Bird Forage Base Preassessment Study (Appendix L), examined the potential chronic toxicity effect of Fore River soft-shelled clams and mussels on migratory birds, providing additional information on

Exhibit 4-14

Soft-Shelled Clam and Blue Mussel Sampling Locations For Sensory Evaluation Tests

(Based on MDMR 1996c)



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Graphic Does Not Represent Precise Locations

hydrocarbon body burdens in these two marine species in the Fore River (USFWS 1997a). This study also reviewed impacts to gastropods and seven other Fore River macroinvertebrates. Impacts to these species groups are summarized in this section. A full discussion of observed impacts to these species can be found in Appendix L.

Soft-shelled clams and mussels were evaluated by the sensory panel in the raw and cooked form in the MDMR study (1996c). Collection station locations for these samples are provided in Exhibit 4-14. With five clams and five mussels collected per station, there were 10 possible detections for each species at each station. Sensory and analytical results for this study are presented in Exhibit 4-15.

Exhibit 4-15

***JULIE N* SENSORY EVALUATION:**
SOFT-SHELLED CLAMS AND BLUE MUSSELS
IN WESTERN CASCO BAY (BASED ON MDMR 1996c)

Station	Species	Number of Sensory Evaluation Hits (per 10 samples [a])
Great Diamond Island	Clams	0
Great Diamond Island	Mussels	0
Chegeaque Island	Clams	0
Chegeaque Island	Mussels	0
Mackworth Island	Clams	0
Mackworth Island	Mussels	0 (per 20 samples)
White Cove	Clams	1
Sandy Point	Mussels	0
Mussel Cove	Clams	0
Mussel Cove	Mussels	0

[a] Unless otherwise indicated

Fore River blue mussel collection locations used in the MDEP-directed Blue Mussel Hydrocarbon Analyses preassessment study (Appendix K, Part 1) can be found in Exhibit 4-16. Four replicate composites, consisting of 20 mussels each with length ranging between 50-60 mm, were collected on November 1, 1996 (MDEP 1996b). Summary chemistry results are presented in Exhibit 4-17 and indicate that total PAH concentrations in Fore River mussels taken after the spill are 10 to 30 times higher than concentrations found in a comparative 1994 Gulfwatch study.

Exhibit 4-16

Fore River Blue Mussel Collection Locations: MDEP Study
(Based on MDEP 1996b)

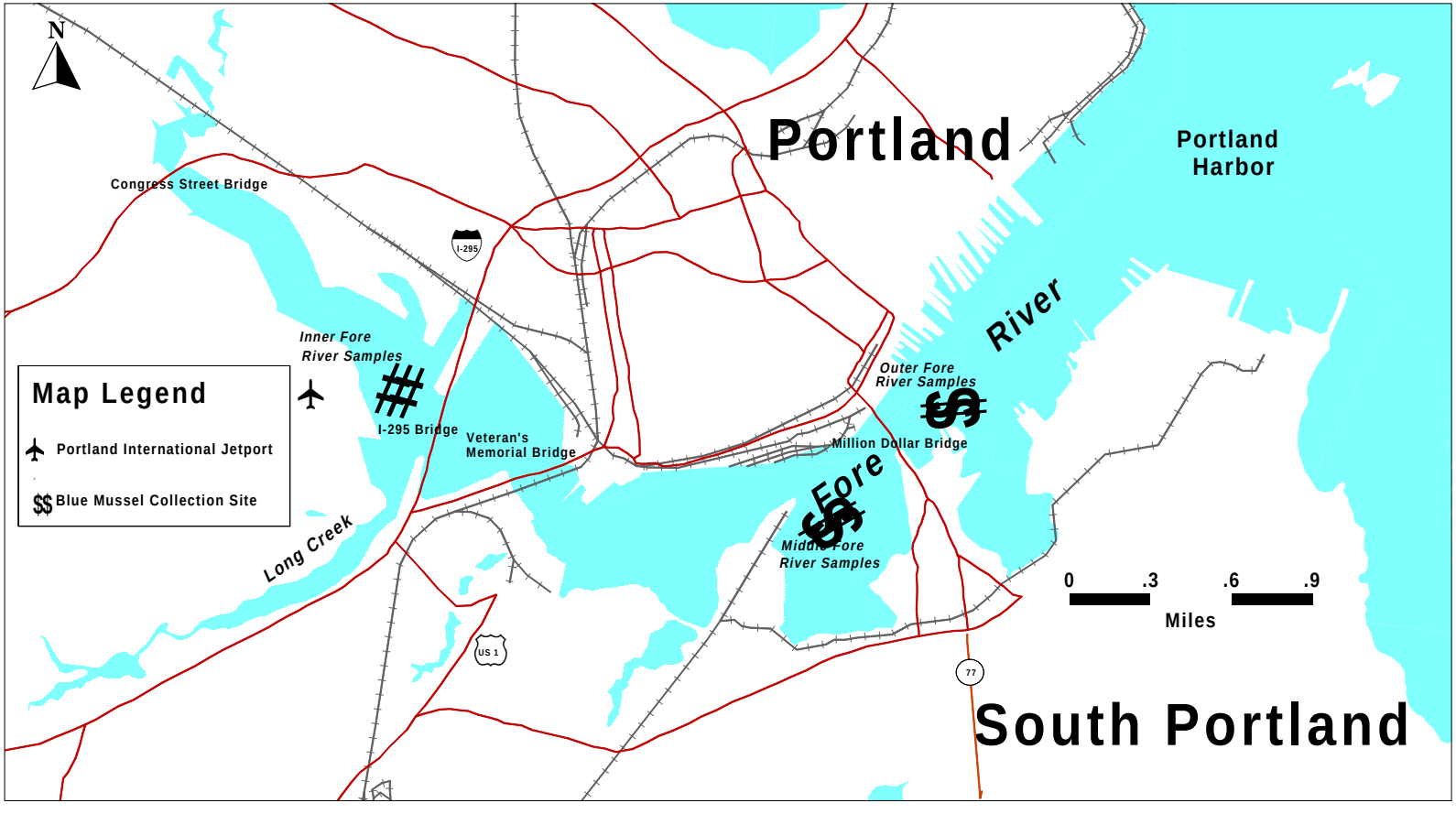

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Exhibit 4-17

COMPARISON OF TOTAL PAH CONCENTRATIONS IN FORE RIVER BLUE MUSSELS COLLECTED NOVEMBER 1, 1996, WITH MUSSELS COLLECTED IN 1994 FOR THE GULFWATCH PROGRAM (BASED ON MDEP 1996b).

Station	Mean Total PAH Concentration (ng/g dry weight)	Standard Deviation (ng/g dry weight)
Inner Fore River	17,800 [a]	15,500 [a]
Middle Fore River	11,000	0
Outer Fore River	7,325	2,029
Gulfwatch	1,098	360

[a] Mussels coated with oil and sheens were on the water surface during sampling.

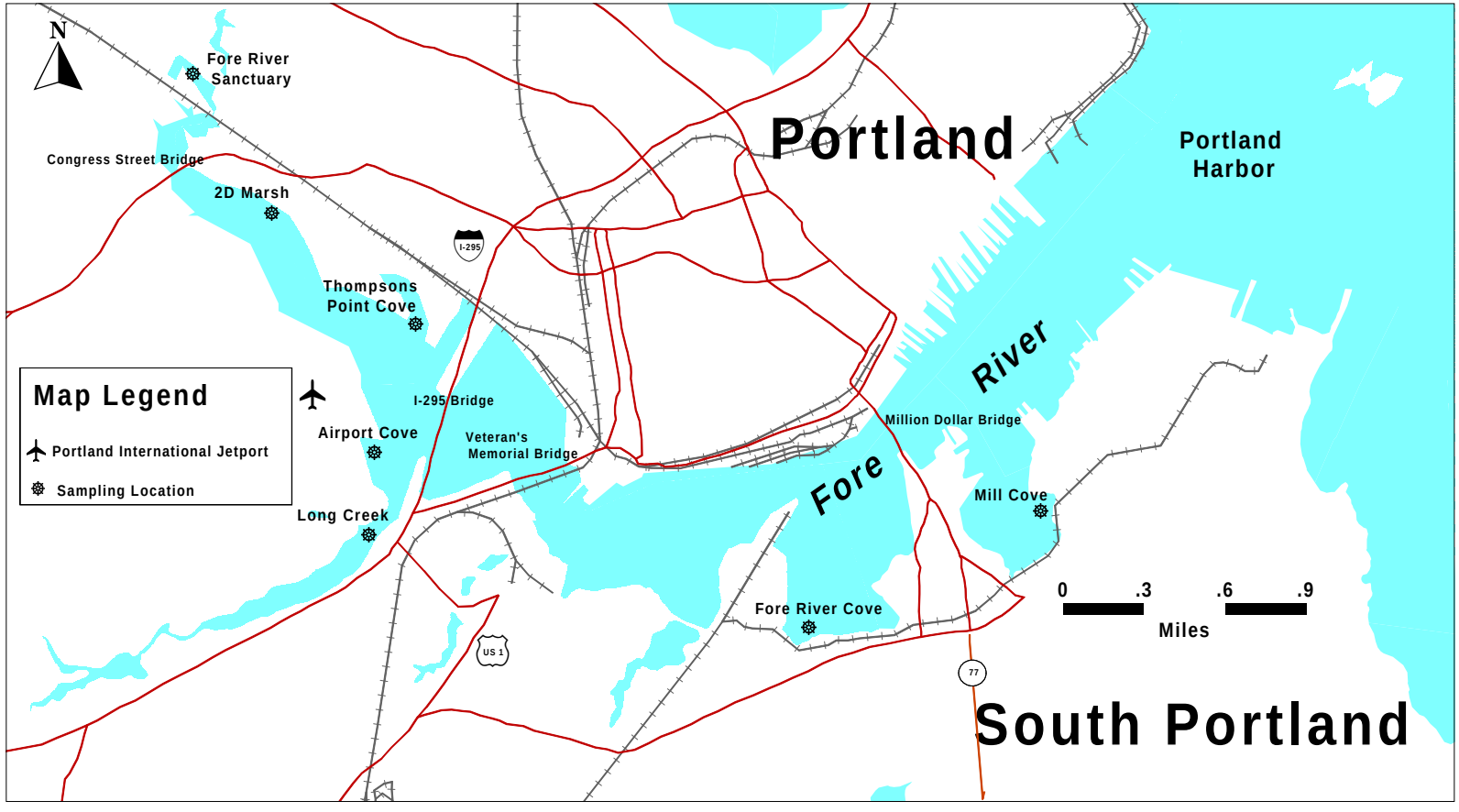
Elevated PAH concentrations in collected blue mussels can be connected to the *Julie N* oil spill in two ways. First, the magnitude of difference between 1994 and post-spill concentrations exceeds expected interannual variability based on Gulfwatch data (see Figure 1a versus Figure 2 in Appendix K, Part 1). Second, the distribution of congeners clearly indicates that more petroleum sourced PAHs are present in the post-spill samples than in the pre-spill samples (MDEP 1996b). Not only are low molecular weight PAHs absent in the Gulfwatch data histograms, but more alkyl-substituted PAHs are present in all three of the post-spill samples (see Figure 1a versus Figures 2-4 in Appendix K, Part 1).

Tissue burdens in blue mussels (and soft-shelled clams and certain gastropods) were examined further in the Migratory Bird Forage Base Preassessment Study (Appendix L). Composites of 10 to 15 mussels and 10 to 15 soft-shelled clams were collected from five impacted areas - i.e., Thompson Point Cove, Fore River Sanctuary, Airport Cove, Long Creek, and Mill Cove - and one potential reference area (Fore River Cove) and analyzed for PAHs to determine potential toxicity to migrating waterfowl (USFWS 1997a). Exhibit 4-18 provides a general location for each shellfish sampling area. Full chemical analytical results from 1996 for soft-shelled clams and blue mussels are included in Attachment 1 to the preassessment study (Appendix L) and summarized in Exhibit 4-19a. Based on this analysis, blue mussels had approximately twice the concentration of PAHs as did soft-shelled clams. Relative to Fore River Cove (reference) mussels, tissue-PAH body burdens in the five studied impacted areas were approximately ten times higher in Thompson Point Cove, three times higher in Long Creek, and two times higher in Airport Cove (USFWS 1997a).

Exhibit 4-18

Fore River Blue Mussel, Soft-Shelled Clam and Gastropod Sampling Locations: USFWS Study

(Based on USFWS 1997a)



Use Only As A General Reference

Graphic Does Not Represent Precise Locations

Exhibit 4-19a

TOTAL PAH CONCENTRATIONS (PPB, DRY WEIGHT) IN SOFT-SHELLED CLAMS AND BLUE MUSSELS COLLECTED AS PART OF THE MIGRATORY BIRD FORAGE BASE PREASSESSMENT STUDY (BASED ON USFWS 1997a)

Sample Location [a]	Species	Date Collected	Number of Individuals in composite	Total PAH (ppb)
TPC-1	Soft-shelled Clam	10/15/96	15	110,000
TPC-2	Blue Mussel	10/15/96	15	290,000
FRS-2	Soft-shelled Clam	10/16/96	15	14,000
AC-1	Soft-shelled Clam	10/16/96	15	25,000
AC-2	Blue Mussel	10/16/96	10	54,000
LC-1	Soft-shelled Clam	10/16/96	15	46,000
LC-2	Blue Mussel	10/16/96	10	81,000
FRC-1	Soft-shelled Clam	10/31/96	15	13,748
FRC-2	Blue Mussel	10/31/96	15	27,007
MC-SC-1	Soft-shelled Clam	11/01/96	15	15,823
MC-BM-1	Blue Mussel	11/01/96	15	28,484

[a] TPC - Thompson Point Cove, FRS - Fore River Sanctuary, AC- Airport Cove, LC - Long Creek, FRC - Fore River Cove, MC - Mill Cove.

In addition to clams, total PAH values in blue mussels were substantially higher in samples collected from nearshore areas than in samples collected from the main channel (Exhibit 4-19a). For example, the total PAH concentration in a composite sample of blue mussels collected inside Thompson Point Cove (290,000 ppb dry wt.) was more than 10 times higher than concentrations found outside the cove in the main channel of the Fore River (28,484 ppb dry wt.). Contamination of Fore River shellfish beds may have resulted in the tainting of food stocks used by local bird populations. Impacts to waterfowl resulting from oil ingestion are addressed in Appendix L.

Results from oil fingerprinting source allocation analysis performed by ADL using double source ratio plots for mussel and clam samples indicated that all samples fell within the *Julie N* ellipses, with the exception of two mussel samples, one from Fore River Cove and one from Mill Cove (Figures 8 and 9, Appendix V). The allocation of petrogenic and non-petrogenic PAHs correspond closely to the allocations for the four sediments plotting in the *Julie N* ellipses. In addition, the PAHs distribution patterns correspond with slightly weathered *Julie N* oil (i.e. the 2- and 3-ring PAHs have been depleted relative to the 4- to 6-ring PAHs). These results indicate that *Julie N* oil is the most likely source of petrogenic PAHs in these samples.

All six areas surveyed in the mainstream of the Fore River showed little to no evidence of acute mortality of bivalves, gastropods, or macroinvertebrates. Similarly, all seven nearshore areas surveyed showed little to no evidence of acute mortality in bivalves, gastropods, or macroinvertebrates. *Mya sp.* individuals determined to have recently died had no flesh remnants and had not accumulated any algae. Exact determination of the time of death for individuals in oil-impacted areas was not possible. However, since some live individuals that had been exposed to oil were showing common oil-related symptoms such as moribund or minimal neck retraction, it is

plausible that some mortality may have occurred (USFWS 1997a). Similar conditions existed for *Mytilus sp.*, especially in Thompson Point Cove. *Mytilus* and *Littorina* were exposed to oil during each tidal cycle and would be expected to have a high potential for incurring mortality. Due to a high intertidal niche, *Littorina* was subjected to external oil coating during the initial stages of the spill in most impacted areas. *Littorina* and *Mytilus* are normally closed during exposed tidal conditions; therefore, it was difficult to determine species viability. Typically, bivalves are capable of closing up for extended periods of time during high stress situations, such as exposure to oil. The duration of closure, reduction in feeding, or exposure to oil will impact their survival and may cause delayed mortality. Residual oil on *Spartina* and in intertidal sediments also may cause chronic impacts to bivalves and gastropods. Additionally, ingestion of contaminated bivalves and gastropods by wintering waterfowl has the potential to cause chronic impacts to avian reproduction and survival.

Macroinvertebrate acute mortality was not readily apparent from the migratory bird preassessment study. There were no visible signs of mortality in oil-impacted areas (USFWS 1997a). However, there was an absence of macroinvertebrates in the more heavily impacted areas. Most areas had sediment organic layers that were relatively shallow. This organic layer is expected to support biotic activity predominantly in the sediments. Those areas that were most heavily exposed (i.e., Thompson Point, 2D Cove, Airport Cove, and Long Creek) typically had substantial brown oil in the upper organic layer, in addition to having repeated surficial sediment oil exposure during tidal fluxes. This oil exposure scenario is expected to have produced chronic and potentially acute impacts on the macroinvertebrate populations within the most heavily exposed areas (USFWS 1997a). Tidal fluxes may be responsible for removing invertebrate mortality.

Additional monitoring of soft-shelled clams and mussels was conducted by MDEP in 1998. As shown in Exhibit 4-19b, some of the PAH levels dropped significantly compared to 1996 (see Exhibits 4-17 and 4-19a). For example, total PAH for mussels at sample location TPC-2 decreased to 5800 ppb. The 1998 monitoring effort was not as extensive as the earlier analyses. Appendix K, Part 2 contains the results of the chemical analysis of the mussel and clam samples.

Exhibit 4-19b

TOTAL PAH CONCENTRATIONS (PPB, DRY WEIGHT) IN SOFT-SHELLED CLAMS AND BLUE MUSSELS COLLECTED IN 1998

Sample Location	Species	Date Collected	Number of Individuals in Composite	Total PAH (ppb)
TPC-1	Soft-Shelled Clam	2/4/98	10	24,000
TPC-2	Soft-Shelled Clam	2/4/98	10	5,600
TPC-2	Mussels	2/4/98	10	5,800

4.2.3 Hard-Surface Vertical Wall Community Impact Study

Based on a recommendation from the Friends of Casco Bay, a preassessment study entitled Vertical Wall Biotic Community Diver Survey (Appendix M) was conducted under the supervision of MDEP to assess the impacts of the *Julie N* oil spill on biological communities that inhabit vertical engineered structures located in marine environments (MDEP 1996c). In Portland Harbor vertical walls such as granite, concrete, steel and wood pilings and cribwork provide substantial habitat within the area of spill impact. The trustees chose not to study cleaned vertical walls, under the assumption that cleaning operations resulted in vertical wall community mortality.

On November 11, 1996, a professional diver/fishery biologist using a High-Eight format mini-camera filmed one reference wall that was not exposed to floating oil near the mouth of Back Cove and five hard vertical walls and pilings that were known to have been in areas exposed to floating oil (Exhibit 4-20). Filming occurred as close to high tide as possible to provide buoyancy to organisms and allow animals to extend from shells and burrows. A weighted line marked in 0.5 meter increments was suspended from the high-tide line to aid in determining vertical positions (zonation) while viewing the tapes. As the diver encountered biota that were not obviously healthy, he touched or prodded the specimen to elicit a response.

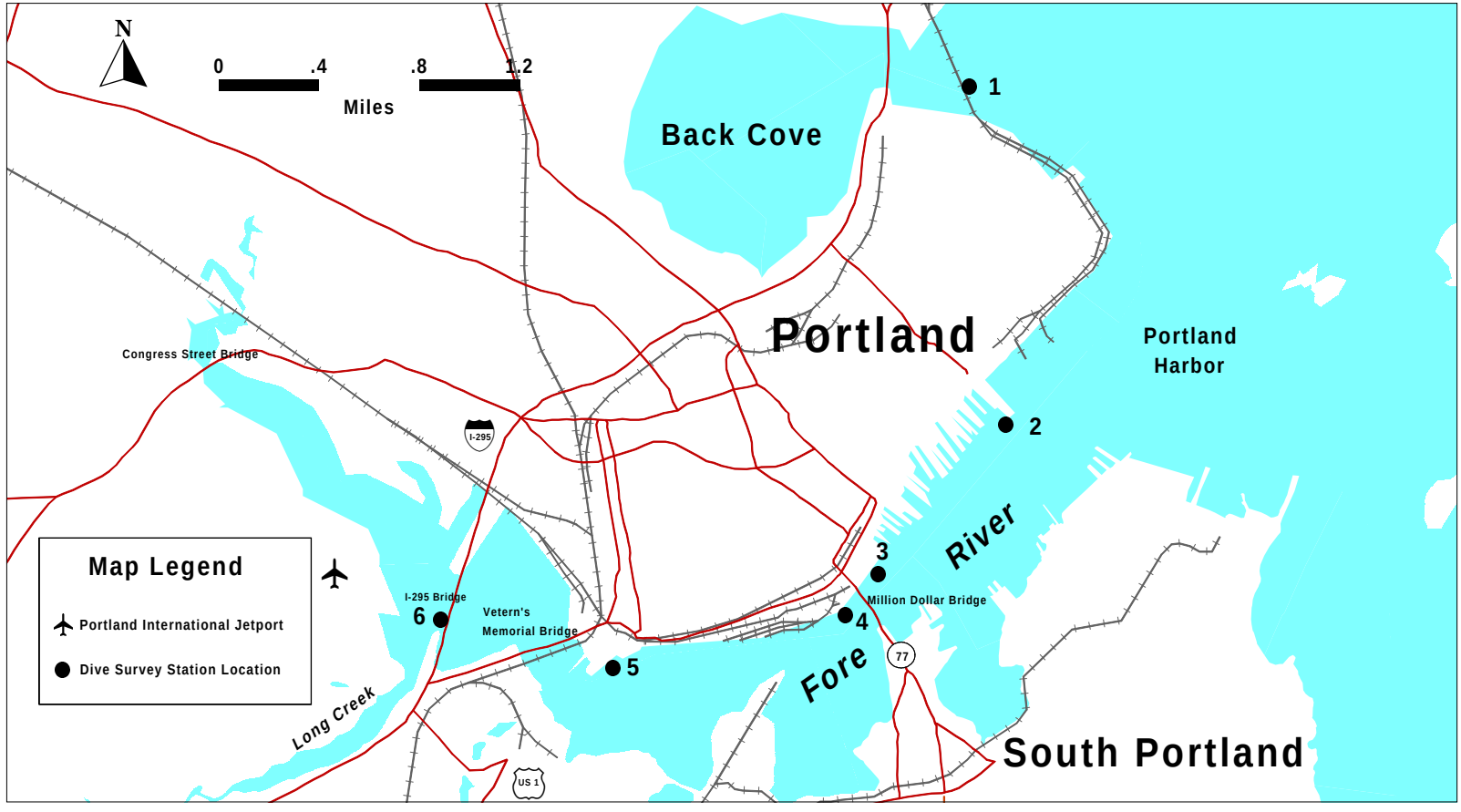
Although oil was found covering barnacles and mussels during the dive survey, they were observed to be actively filtering. Anemones within the oil stained area were also open and alive. In the subtidal zone, hydroids and stalked ascidians were dead. Unlike barnacles, mussels, and to some extent anemones, stalked ascidians are not able to retract during adverse conditions. Exposure to hydrocarbon toxicity in surface water would have been possible at low tide.

However, in addition to oil contamination at least two other natural stressors may be involved. First, hydroids and ascidians are short-lived, naturally dying back in late fall - at about the time of the dive (MDEP 1996c). For example, *Tubularia*-type hydroids were observed in the Harraseekett estuary after the dive survey only 15 miles east of Portland (MER 1996). Second, southern Maine experienced record rainfall (19") during a Northeaster about one week prior to this dive survey. Salinities in the upper two meters of the water column in the inner Harbor dropped to 6 parts per thousand following the storm (Joe Payne, personal communication). The Harraseekett hydroids were not exposed to unusually low salinities since that area and its watershed did not receive unusually high amounts of precipitation or runoff from the Northeaster. Further, the hydroids observed at the Back Cove outlet during the Subtidal Benthic Community Diver Survey (Appendix N) were not observed after the flood. During the present study, the diver reported strong currents at that site which may have scoured any dead hydroids from the trestle (i.e. at Station 1, the reference station). Therefore, it may not be possible to ascribe dieback of these two species to exposure to oil.

Short-term effects on hydroids and ascidians may have been obscured by the low salinities in the general area following the spill. Long-term effects, including effects from cleaning and other response activities, are not addressed in this study.

Exhibit 4-20

Vertical Wall Station Locations
(Based on MDEP 1996c)



Use Only As A Geneal Reference

Graphic Does Not Represent Precise Locations

Station-specific results from this survey can be found in the vertical wall preassessment study (Appendix M). The video record is being held as part of the Administrative Record at the Maine Department of Environmental Protection's Portland Field Office.

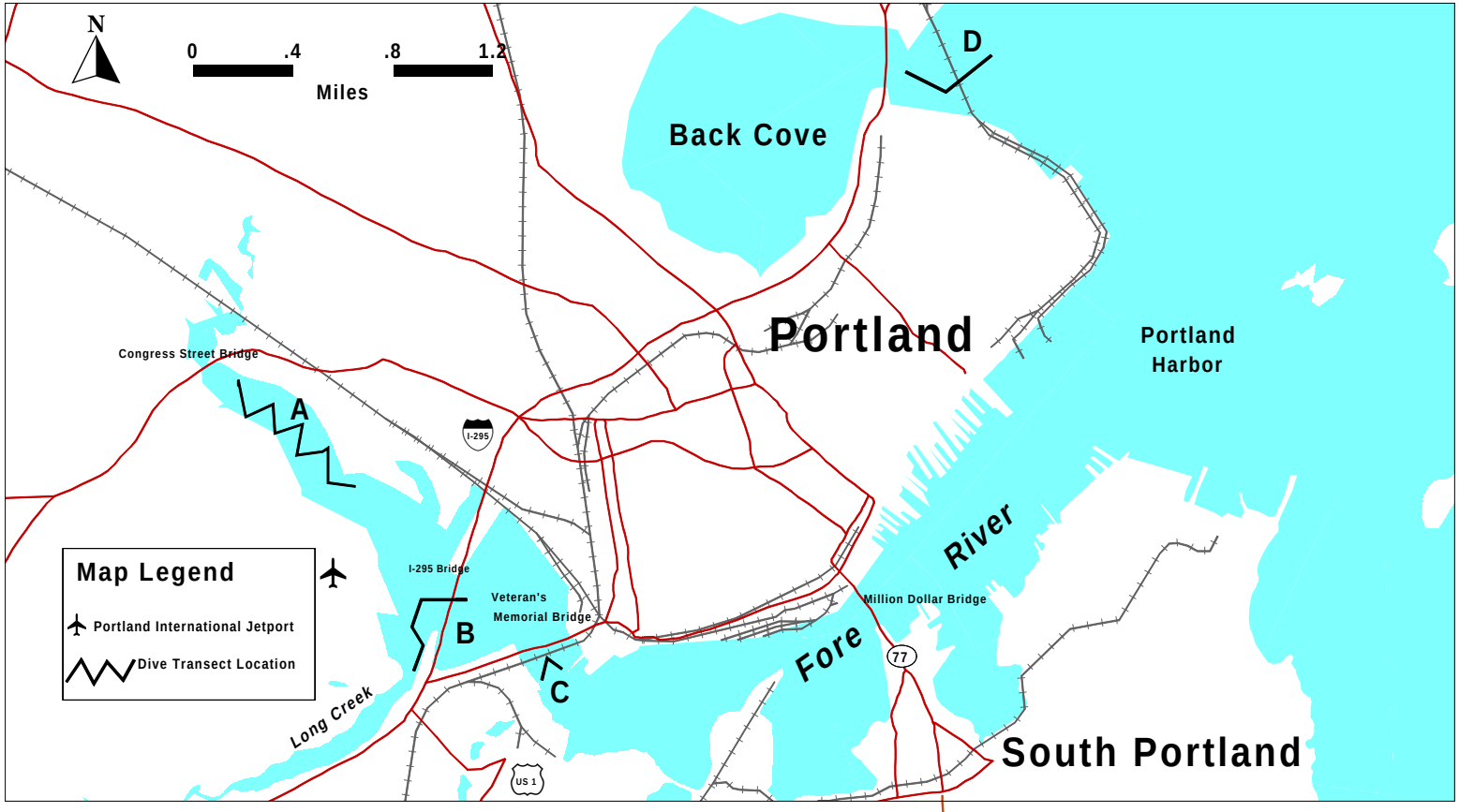
4.2.4 Marine Benthic Community Impact Study

The objective of the MDEP-directed Subtidal Benthic Community Diver Survey (Appendix N) was to examine the bottom of the Fore River estuary for obvious signs of stress, mortality and oil (MDEP 1996d). If oil was found, the MDEP would map the extent of contamination. Four transects were filmed using a High-Eight format mini-camera on October 7, 1996: the middle Stroudwater Estuary; the mouth of Long Creek; the Fore River seaward of Veteran's Memorial Bridge at Sprague Terminal; and a reference site in Back Cove outlet (Exhibit 4-21). The diver was a professional diver/fishery biologist. The diver swam slow transects in a "zigzag" pattern across areas documented as having been exposed to large volumes of floating oil. The initial workplan committed to documenting bottom conditions in the Stroudwater Estuary, Long Creek, and the inner Fore River near the Sprague Terminal. If signs of stress, mortality or bottom oil was found, transects would continue out the Fore River until "background" conditions were located. Background conditions were based on conditions found at the outlet of Back Cove, where substrate, salinity, and human activity are relatively similar. As the diver encountered biota that were not obviously healthy, he touched or prodded the specimen to elicit a response. All dead or moribund organisms were collected and brought to the surface for examination.

Video footage from the dives is being held as part of the Administrative Record at the Maine Department of Environmental Protection at the Portland Field Office. A complete discussion of dive observations can be found in the subtidal benthic preassessment study (Appendix N). In summary, no signs of oil were observed during the dives at all four sites. Organisms appeared to be in generally good health. Two dead green crabs were found at the mouth of Long Creek (site B) and brought to the surface for further examination. No outward evidence of oil existed and given the abundance of living green crabs observed at site "B" (i.e. approximately 500 green crabs), the occurrence of two dead green crabs was not considered to be unusual.

Exhibit 4-21

Dive Transect Locations Used in Subtidal Benthic Community Diver Survey (Based on MDEP 1996d)



Use Only As A General Reference

Graphic Does Not Represent Precise Locations

4.3. SEDIMENT QUALITY

Sediment is a major repository for contaminants entering marine ecosystems. As such, sediment quality data are useful when describing the contamination history for an area. Biologically, sediment contamination has the potential to adversely affect resident biota associated with the sediment, (including infaunal organisms such as marine worms and clams) and higher organisms dependent upon those biota as a food stock (e.g. birds). Two studies were conducted to determine the impact of the *Julie N* oil spill on baseline sediment quality with respect to petrogenic hydrocarbon concentrations. The primary objective of the MDEP-directed Sediment Quality preassessment study (Appendix O) was to determine whether concentrations of hydrocarbons in surficial sediments had increased following the *Julie N* oil spill as compared with similar data collected by the Maine Marine Environmental Monitoring Program in 1989 (MDEP 1996e). Similarly, the purpose of USFWS-directed Surface Sediment Oiling Study (Appendix P) was to determine the change in PAH concentrations in spill-impacted intertidal sediments of selected nearshore areas relative to a similar reference area (USFWS 1997b). The results of these studies are discussed in the following two sections.

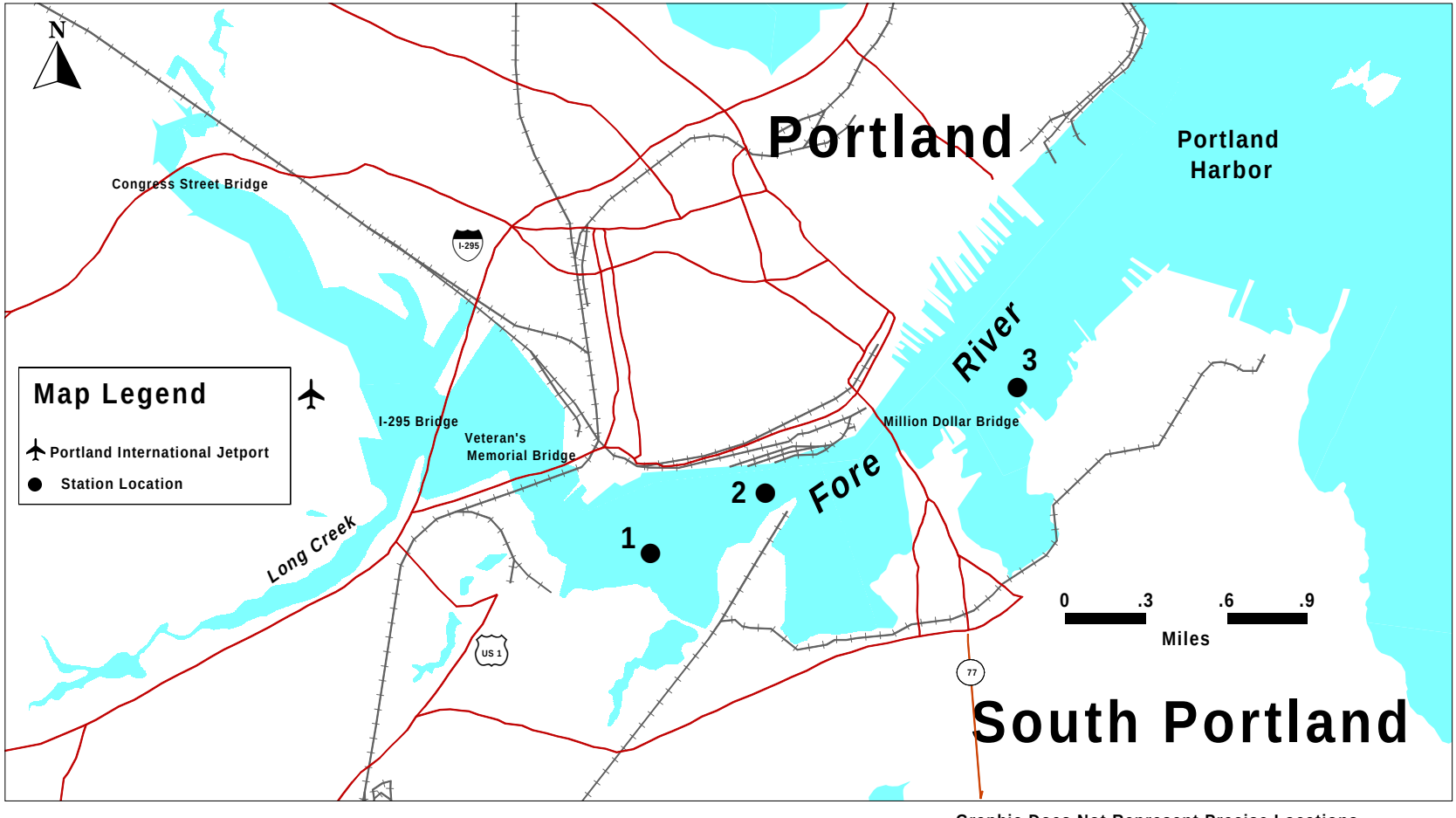
4.3.1. MDEP Sediment Quality Preassessment Study

Three Maine Marine Environmental Monitoring Program (MEMP) stations had been previously sampled within the spill area in 1989 (Exhibit 4-22). These sites were selected for post-spill sediment sample collection (MDEP 1996e). Sediment sampling occurred on November 11, 1996. Analytical results for these samples are presented with respective hydrocarbon concentrations from a 1989 sampling survey in Exhibit 4-23.

Exhibit 4-22

Fore River Sediment Quality Station Locations: MDEP Study

(Based on MDEP 1996e)



Use Only As A General Reference

Graphic Does Not Represent Precise Locations

Exhibit 4-23

TOTAL PAH CONCENTRATIONS (PPB DRY WEIGHT) IN FORE RIVER SURFICIAL SEDIMENTS BEFORE AND AFTER THE *JULIE N* INCIDENT (BASED ON MDEP 1996e).

Station	1989 Sampling Survey				November 11, 1996 Sampling Survey			
	Sample 1	Sample 2	Sample 3	Mean/Standard Deviation	Sample 1	Sample 2	Sample 3	Mean/Standard Deviation
Station 1	11,027	11,329	13,318	11,891 / 1245	14,000	17,000	14,000	15,000 / 1732
Station 2	11,063	16,992	14,340	14,132 / 2970	14,000	14,000	13,000	13,667 / 577
Station 3	10,061	10,814	9,762	10,212 / 542	16,000	21,000	14,000	17,000 / 3606

Levels of total PAHs in 1 to 2 centimeters surficial sediments from Station 3 (i.e. seaward of the Million Dollar Bridge) collected and analyzed after the *Julie N* spill are significantly higher than PAH concentrations found at this station in 1989 (as determined by a one-tailed Students t-test where $a = 0.05$). However, differences in total PAH concentrations at these stations do not necessarily translate into degree of impacts on biota. Furthermore, it is difficult to reoccupy sediment stations with any precision. Thus, differences could reflect spatial as well as temporal variations, making comparisons between the 1989 MEMP and 1996 post-spill sediment quality data sets difficult.

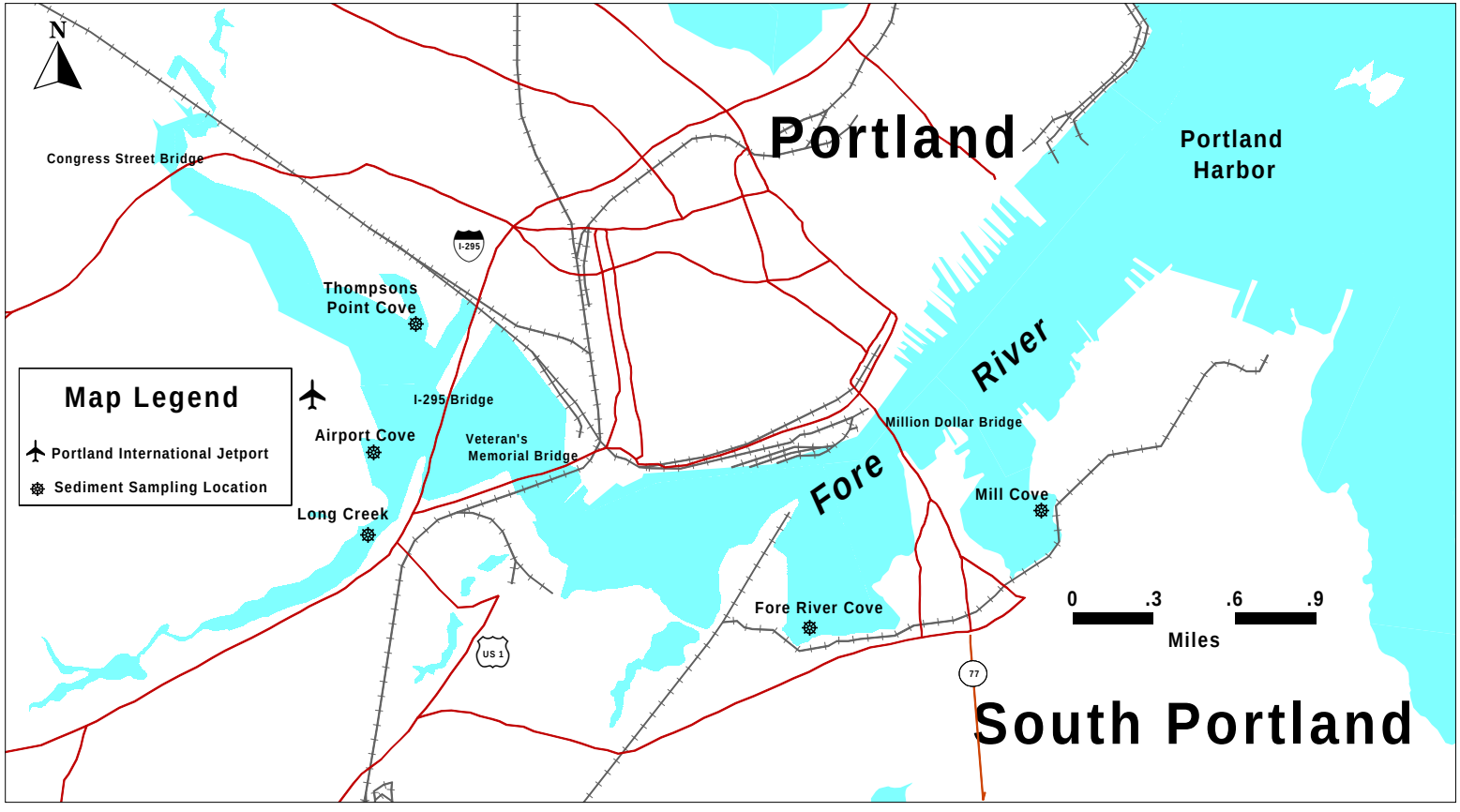
However, examination of individual congeners (see Figures 3-5 in Appendix O) indicates that much of the difference between the samples may be attributed to lighter molecular weight PAHs, especially the C2, C3, and C4 naphthalenes, phenanthrene/anthracenes, and fluorenes that are generally abundant in petroleum products. This pattern continues in a comparison of more recent (1991) analyses from Stations 3 (which is in the same location as Station 1B-1 of the Casco Bay Estuary Project, see Attachment C in Appendix O). Because light molecular weight PAHs are easily metabolized, they may not persist for a long period in the environment. The presence of light molecular weight PAHs in the November 1996 sediment samples suggests recent PAH contamination of surficial Fore River sediments.

4.3.2 USFWS Surface Sediment Oiling Study

Three sediment cores were collected during low tide from each of four impacted areas: Thompson Point Cove, Airport Cove, Long Creek, and Mill Cove and one from Fore River Cove, a potential reference area (Exhibit 4-24). Impact and reference areas were chosen from data collected during the response phase of the spill (NOAA trajectory models, shoreline surveys, and aerial overflight data). Samples from a second reference area (Presumpscot River) were collected during low tide and archived as a real-time reference, if analytical results from the Fore River sample indicated that the site may have been impacted by the spill. Dates, location descriptions and GPS coordinates (where available) for each sample area are summarized in Table 3, attached to the surface sediment oiling preassessment report (Appendix P). Cores were collected between October 30 and November 1, 1996, using a stainless steel Ekman dredge that was forced into the

Exhibit 4-24

Fore River Sediment Quality Station Locations: USFWS Study
(Based on USFWS 1997b)



Use Only As A General Reference

Graphic Does Not Represent Precise Locations

sediment, and the top five centimeters were placed in chemically clean 16 ounce amber glass jars and stored on ice. One additional sample per area was collected, sieved (using a 60 mesh sieve), and the contents were placed in a plastic jar and preserved in formalin. This sample was archived in the event that a determination of the species of soft-bodied infaunal organisms, which were present during the sampling, was required by either the trustees or the RP (USFWS 1997b).

A complete scan of PAH constituent concentrations in collected sediments are included in Appendix 1 to the study report (Appendix P) and summarized in Exhibit 4-25 below. Mean PAH values (parts per billion, dry weight) are significantly higher ($P < 0.05$) in Thompson Point Cove than in the other four sites of this study. Summary statistics suggest that only Thompson Point Cove had statistically significant elevated PAH levels as compared to the designated reference area (Fore River Cove). Mean values, however, are a combination of background PAH levels and new inputs from the *Julie N* oil spill. Mean values also do not adequately describe the heterogeneous distribution of PAH levels within each sampling area (i.e. note standard deviations).

Another way to determine exposure from PAHs is to look at the ratio of light molecular weight PAHs as a percent of total PAHs (USFWS 1997b). Because lighter molecular weight PAHs are relatively easily metabolized, they would not be expected to persist long in the environment. The percentage of lower molecular weight PAHs (up to C4-phenanthrenes/ anthracenes) are summarized in Exhibit 4-26. Samples that had higher ratios of light PAHs suggest recent exposure from a petroleum product. If we assume that the Fore River Cove ratio (approximately 24 percent) represents a potential background ratio of light molecular weight PAHs to total PAHs, then all three samples in both Thompson Point Cove and Long Creek, one sample in Airport Cove, and one sample in Mill Cove exhibit recent exposure to a petroleum product (USFWS 1997b) .

Source oil analyses of contaminated sediment samples collected at the sites in this study were analyzed by ADL (1997). All sediment samples contained a mixture of petrogenic, pyrogenic and biogenic PAH. The allocation of non-petrogenic PAH (pyrogenic and biogenic) ranges from 14 to 65 percent of total PAH, with the majority of non-petrogenic PAH accounting for 45 to 60 percent of the total PAH. Four sediment samples had distinctly different PAH distributions: two from Thompson Point, and one each from Airport Cove and Long Creek (Exhibit 4-24). Petrogenic PAH for these samples were calculated to be 70 to 90 percent of the total PAH, while pyrogenic and biogenic contributions were lower than the other sediments (<27 percent and <0.6 percent, respectively). In addition, double source ratios for these four samples plot within the *Julie N* oil ellipses, as illustrated in Figure 2 (Appendix V). This result indicates that the PAHs in these samples are likely associated with petrogenic PAHs from the *Julie N* oils. Based upon PAH fingerprinting studies conducted by Arthur D. Little, four sediment samples, Thompson Point Sample 2, Thompson Point Sample 3, Airport Core Sample 3 and Long Creek Sample 1, yielded oil which was consistent with *Julie N* oil. However, all sediment samples were collected after the October 20-21, 1996, northeastern storm event, which may have resulted in significant redistribution of sediments in the Fore River.

The remaining sediment samples had petrogenic contributions of approximately 40 to 50 percent, and double source ratios which clustered to the lower left of the *Julie N* oil ellipses (Figure 2, Appendix V). Thus, all the petrogenic PAHs were allocated to other petroleum sources for these samples.

Exhibit 4-25

TOTAL PAH CONCENTRATIONS (PPB, DRY WEIGHT) IN FORE RIVER SURFICIAL SEDIMENTS COLLECTED OCTOBER 30 - NOVEMBER 1, 1996 (BASED ON USFWS 1997b)

Sample Location	Replicate Sample 1	Replicate Sample 2	Replicate Sample 3	Mean	Standard Deviation
Thompson Point Cove	30,000	67,000	62,000	53,000	20,075
Airport Cove	8,400	26,000	11,000	15,133	9,500
Long Creek	3,600	2,000	12,000	5,867	5,370
Fore River Cove	16,000	14,000	18,000	16,000	2,000
Mill Cove	24,000	23,000	15,000	20,667	4,932

Exhibit 4-26

PERCENTAGE OF LOW MOLECULAR WEIGHT PAHs IN SEDIMENT SAMPLES COLLECTED OCTOBER 30 - NOVEMBER 1, 1996 (BASED ON USFWS 1997b)

Sample ID	Total PAH (ppb)	Percent Low Molecular Weight PAHs [a]
Thompson Point Cove Sample 1	30,000	33%
Thompson Point Cove Sample 2[b]	67,000	64%
Thompson Point Cove Sample 3[b]	62,000	55%
Airport Cove Sample 1	8,400	25%
Airport Cove Sample 2	26,000	54%
Airport Cove Sample 3[b]	11,000	21%
Long Creek Sample 1[b]	3,600	54%
Long Creek Sample 2	2,000	35%
Long Creek Sample 3	12,000	32%
Fore River Cove Sample 1	16,000	23%
Fore River Cove Sample 2	14,000	24%
Fore River Cove Sample 3	18,000	24%
Mill Cove Sample 1	24,000	26%
Mill Cove Sample 2	23,000	28%
Mill Cove Sample 3	15,000	26%

[a] Lower molecular weight PAHs include PAH compounds up to C4-Phenanthrenes/anthracenes)
[b] According to the fingerprinting analysis, these samples can be tied directly to the *Julie N* spill.

Long et al. (1995) calculated guideline values that delineate three concentration ranges for various chemicals in coastal sediments. Concentrations below the ERL (effects-range-low) value estimate conditions in which effects would be rarely observed. Concentrations between the ERL and the ERM (effects range medium) value represent a possible-effects range. Concentrations above the ERM represent a probable effects range. The ERL value (4022 ppb) and ERM value (44792 ppb) for total PAH suggests that most sites in the spill area (with the exception of the outer portion of Long Creek) show concentrations where adverse effects are

possible. In Thompson Point Cove, two samples exceeded the ERM which strongly suggests that there were, and may continue to be, adverse effects to biota that are in contact with sediments in the middle and upper reaches of Thompson Point Cove (USFWS 1997b).

4.4. BIRDS

On September 29, 1996, staff from the Maine Department of Inland Fisheries and Wildlife (MDIFW) and the U.S. Fish and Wildlife Service began monitoring the Fore River area daily to document bird use in the area, to capture oiled birds for rehabilitation and to collect dead birds for evidence (MDIFW 1996a). On October 14, Casco Bay Environmental (CBE) was hired to replace MDIFW and USFWS staff for the duration of the project. Ground monitoring continued until November 19, when the project was terminated due to the very low percentage of oiled birds observed and the lack of oiled or dead birds recovered. The report resulting from this work can be found in Appendix Q, Continuation of Bird Monitoring and Collection of Oiled Birds.

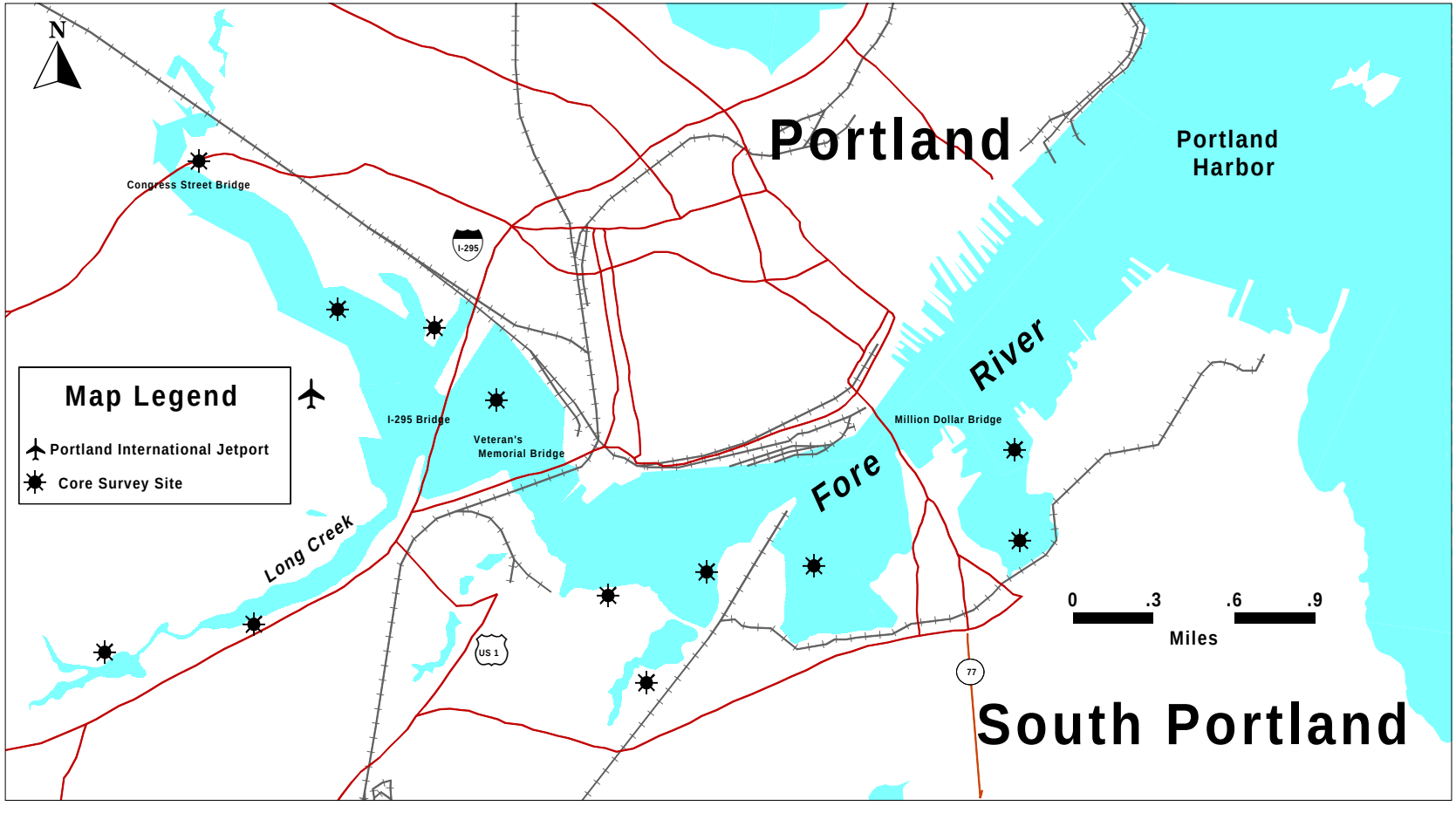
In addition to the ground surveys from the shoreline, aerial bird distribution and abundance surveys of waterfowl, wading birds and shorebirds were conducted by MDIFW (1996b) until December 13, 1996, to determine the potential for exposure to oiled habitats in the Fore River. The results of these surveys can be found in Appendix R, Wading Bird, Waterfowl, and Shorebird Distribution and Abundance Survey.

The Fore River area was monitored for oiled birds from September 29 to November 19, 1996. Daily surveys were conducted between September 29 and October 25, at which point survey effort was reduced to two high tide and two low tide surveys per week. Twelve core survey sites (Exhibit 4-27) were identified to record bird observations, capture oiled birds for rehabilitation, and collect dead birds. These sites were visited at least once during each survey period. Seven additional survey sites were monitored intermittently as time permitted. Data collected at each site included date, weather, survey team, survey site, species observed and number of birds observed by degree of visible oiling. Birds were categorized as unoiled, lightly oiled, moderately oiled, or heavily oiled according to a standardized methodology provided by Beak Consultants (see Figure 2 in Appendix Q).

Forty-two species of birds were observed at the core survey sites in the spill area (MDIFW 1996a). Two observations of the endangered Peregrine Falcon *(Falco peregrinus)* species were recorded, as well as twenty-one occurrences of Black-crowned Night-herons *(Nycticorax nycticorax),* a species of special concern to the Maine Department of Inland Fisheries and Wildlife. The Peregrine Falcons observed were most likely migrating through the area. Because species abundance is affected by tide levels, data was summarized by low and high tide observations (see Tables 2 and 3 in Appendix Q). Low tide observations occurred within two hours of low water, and high tide observations occurred within two hours of high water. Data in Table 1 (Appendix Q) were collected during all tidal periods (low, incoming, high, and outgoing) whereas Tables 2 and 3 (Appendix Q) include only low and high tide observations, respectively. Bird abundance trends by tide for specific taxa are illustrated in Figures 3 and 4 (Appendix Q).

Exhibit 4-27

Fore River Bird Monitoring, Capture and Collection Core Survey Sites
(Based on MDIFW 1996a)



Use Only As A General Reference

Graphic Does Not Represent Precise Locations

Both dabbling and diving duck numbers increased in Fore River area as wintering populations arrived. Wading bird, shorebird, and cormorant observations declined as migrant populations moved out of the area.

The number of birds observed that showed visible signs of oiling are summarized by date and by species (Exhibits 4-28 and 4-29, respectively). In many cases, observers were unable to ascertain the degree of visible oiling according to the standardized methodology due to distance or dark plumage (e.g. black ducks).

Twenty-eight live oiled birds were captured in the Fore River area and brought to the rehabilitation center. Exhibit 4-30 presents the fate of these birds. Twelve birds were rehabilitated and released. One bird remained in rehabilitation and 15 birds died while at the rehabilitation center (including a Black-crowned Night heron, a special concern species in Maine). Twelve birds found dead were collected and the carcasses were stored by the U.S. Fish and Wildlife Service. All of these birds were either captured or collected prior to October 14, 1996 (MDIFW 1996a).

Exhibit 4-28

NUMBER OF BIRDS BY DATE SHOWING VISIBLE SIGNS OF OILING (BASED ON MDIFW 1996a)

	Visible Oiling				No Visible Oiling
Date	**Light**	**Moderate**	**Heavy**	**Total**	**Total**
09/29/96	7	3		10	280
09/30/96	92	144		236	397
10/01/96	173	117	2	292	639
10/02/96	187	55	25	267	788
10/03/96	70	35	14	119	839
10/04/96	278	32	10	320	1070
10/05/96	73	29	1	103	402
10/06/96	34	20	11	65	1247
10/07/96	26	27	13	66	435
10/08/96	15	9	4	28	968
10/09/96	27	6	3	36	865
10/10/96	8	2		10	365
10/11/96	12	2		14	1174
10/12/96				0	455
10/13/96	1		2	3	176
10/14/96	1	4		5	921
10/15/96	13	4		17	832
10/16/96	5	2	1	8	1165
10/17/96	5	2	1	8	895
10/18/96	8	3		11	818
10/19/96	11	1		12	1042
10/20/96	1	1		2	770
10/21/96	1	1		2	311
10/22/96	2			2	518
10/23/96	6			6	738
10/24/96	4			4	1063
10/25/96	2	2		4	888
10/28/96	1	3		4	214
10/29/96	1	1		2	523
10/31/96				0	68
11/01/96	1			1	49
11/04/96	7	1		8	888
11/05/96	7			7	859
11/07/96				0	25
11/08/96				0	35
11/11/96				0	897
11/12/96	3	2		5	565
11/14/96				0	94
11/15/96				0	76
11/18/96				0	1163
11/19/96	2			2	1165
Total	1,084	508	87	1,679	**26,682**

Exhibit 4-29

NUMBER OF BIRDS BY SPECIES SHOWING VISIBLE SIGNS OF OILING (BASED ON MDIFW 1996a)

Species	Visible Oiling				No Visible Oiling
	Light	Moderate	Heavy	Total	Total
Gulls	592	321	28	941	4,479
Ring-billed Gulls	101	70	29	200	6,506
Herring Gulls	157	31	3	191	4,250
Great Black-backed Gulls	10	2	1	13	2,111
Bonaparte's Gulls	0	0	0	0	2
Gull Subtotal	860	424	61	1345	17,348
Black Duck	34	14	4	52	5,481
Mallard	6	1	0	7	1,110
Wood Duck	0	0	0	0	17
Green-wing Teal	0	0	0	0	70
Ring-necked Duck	0	0	0	0	5
Goldeneye	0	0	0	0	14
Bufflehead	0	0	0	0	562
Merganser	0	0	0	0	97
Duck Subtotal	40	15	4	59	7,356
Common Eider	1	1	0	2	27
Canada Geese	0	0	0	0	28
Double-crested Cormorant	121	24	10	155	801
Grebe	0	1	1	2	8
Great Blue Heron	15	8	0	23	89
Green Heron	0	0	0	0	1
Black-crowned Night-heron	0	0	0	0	21
Snowy Egret	4	4	1	9	75
Cattle Egret	0	0	0	0	4
Wading Bird Subtotal	19	12	1	32	190

Exhibit 4-29 (continued)

NUMBER OF BIRDS BY SPECIES SHOWING VISIBLE SIGNS OF OILING (BASED ON MDIFW 1996a)

Species	Visible Oiling				No Visible Oiling
	Light	Moderate	Heavy	Total	Total
Shorebirds	5	11	4	20	54
Plover	0	0	0	0	3
Black-bellied Plover	10	8	3	21	400
Semipalmated Plover	6	6	2	14	28
Dunlin	0	1	0	1	33
Sandpiper	4	0	0	4	60
Least Sandpiper	1	0	0	1	5
Semipalmated Sandpiper	0	3	0	3	32
Solitary Sandpiper	0	0	0	0	2
Western Sandpiper	0	0	0	0	1
Yellowlegs	6	0	0	6	239
Shorebird Subtotal	32	29	9	70	857
Loon	0	0	0	0	2
Kingfisher	4	0	0	4	45
Eagle	0	0	0	0	1
Peregrine Falcon	0	0	0	0	2
Red-tailed Hawk	0	0	0	0	8
Sharp-shinned Hawk	0	0	0	0	1
Raptor Subtotal	0	0	0	0	12
Rail	0	0	1	1	0
House Sparrow	7	2	0	9	0
Sharp-tailed Sparrow	0	0	0	0	1
Song Sparrow	0	0	0	0	7
Passerine Subtotal	7	2	0	9	8
Total	**1,084**	**508**	**87**	**1,679**	**26,682**

Exhibit 4-30

OILED BIRDS COLLECTED OR CAPTURED IN THE FORE RIVER AREA (BASED ON MDIFW 1996a)

Species	Dead on Arrival	Alive on Arrival	Died at Rehabilitation Center	Released	Remained in Rehabilitation
Ring-billed Gulls	1	3	0	2	1
Herring Gulls	4	6	3	3	0
Great Black-backed Gulls	2	1	0	1	0
Black Duck	1	3	2	1	0
Leach's Strom Petrel	0	1	0	1	0
Double-crested Cormorant	3	7	7	0	0
Black-crowned Night-heron	0	1	1	0	0
Black-bellied Plover	0	1	1	0	0
Semipalmated Plover	0	4	0	4	0
Kingfisher	1	0	0	0	0
Mourning Dove	0	1	1	0	0
Total	**12**	**28**	**15**	**12**	**1**

4.5. WATER QUALITY

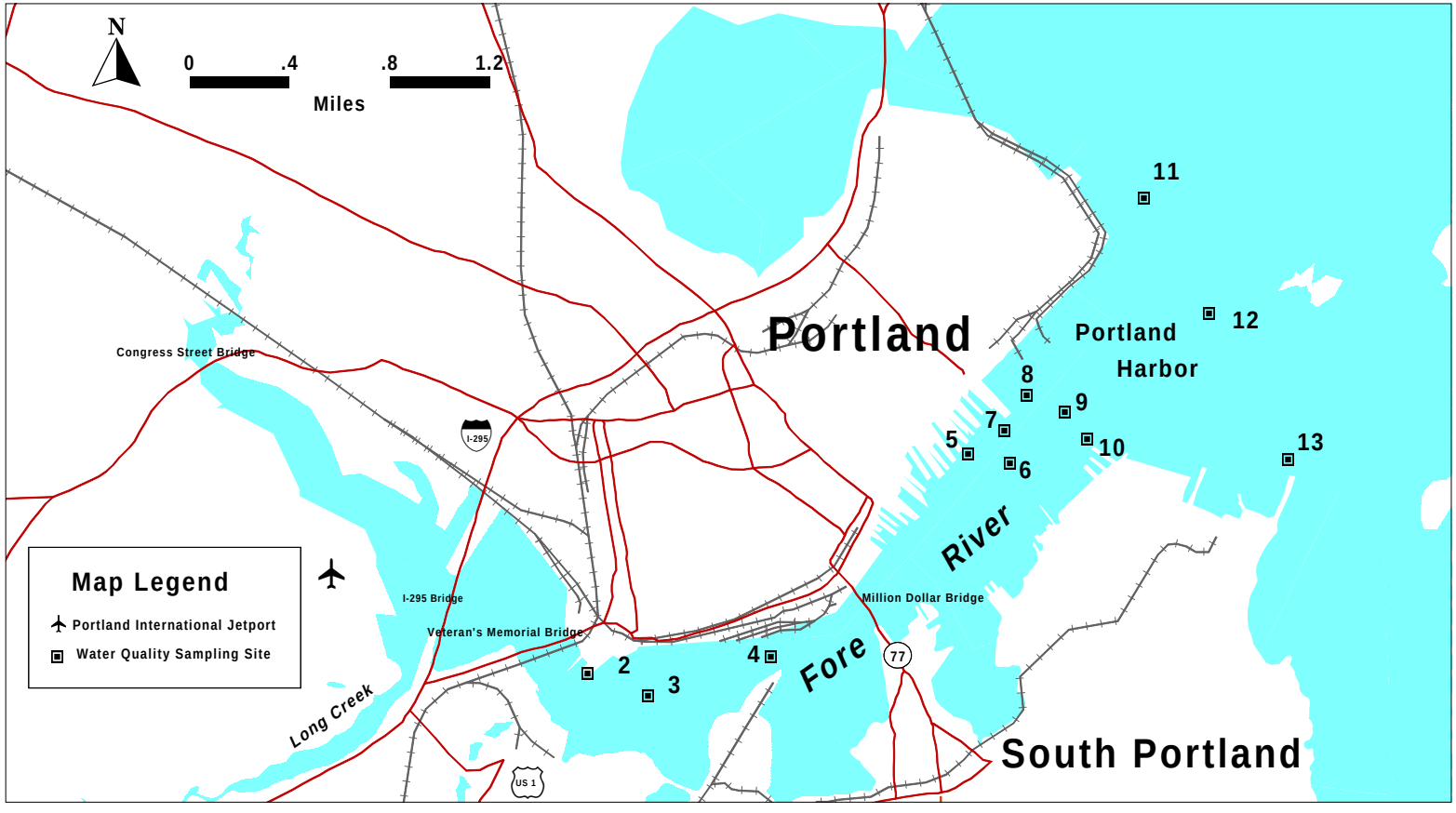
Two water sampling efforts were conducted by the Responsible Party and the Trustees in the Fore River following the Julie N oil spill. One set of water samples was collected down river from the Veteran's Memorial Bridge under the direction of the Responsible Party (Exhibit 4-31). The other set of water samples was collected under the direction of the USFWS and focused on areas up-river from the Interstate 295 Bridge (Exhibit 4-33). It can be noted from Exhibits 4-31 and 4-33 that no water samples were collected between Thompson Point and the Veterans Memorial Bridge, an area approximately one mile in length. This area was heavily contaminated by oils spilled from the Julie N. Differences in sampling methodologies and analytical results from both sampling efforts are summarized in the sections below.

4.5.1 Lower Fore River Water Samples

Thirteen water quality stations were established from above the Veterans Bridge on the Fore River to the mouth of the river (Mauseth 1996). Each station's location was recorded using Global Positioning Systems (GPS) and landmarks and is provided in Exhibit 4-31. At each station two water samples were taken, one at 1.5 feet below the surface and one at three feet above the bottom. The samples were collected with Stainless Kemmerer sampling bottles that were decontaminated prior to sampling and after each sample was taken, according to the protocol found in the Water Sampling preassessment study (Appendix S). A total of three sets of samples were taken, with one set on each of following dates: October 1, 3, and 5, 1996. The October 1 set was analyzed according to a modified 8270 protocol. The October 3 and 5 sample sets were archived. Station one was not sampled due to inaccessibility. Water sampling was conducted on the ebbing tide, commencing at the beginning of the ebb. Analytical results from the October 1 water sample set are provided in Exhibit 4-32.

Exhibit 4-31

Lower Fore River Water Quality Sampling Stations
(Based on Mauseth 1996)



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Graphic Does Not Represent Precise Locations

Exhibit 4-32

TOTAL PAH CONCENTRATIONS IN FORE RIVER WATER SAMPLES COLLECTED OCTOBER 1, 1996[a]

Station	Sample	Sample Location	Sample Depth (feet)	Total PAH
1	N/A[b]	N/A[b]	N/A[b]	N/A[b]
2	2-T-B1	100 feet North of *Julie N*; 300 feet south of Veterans Bridge	Not recorded	140
2	2-B-B1	100 feet North of *Julie N*; 300 feet south of Veterans Bridge	Not recorded	140
2	2-T	100 feet North of *Julie N*; 300 feet south of Veterans Bridge	1.5	760
2	2-B	100 feet North of *Julie N*; 300 feet south of Veterans Bridge	45	1300
3	3-T	At Buoy 5	1.5	740
3	3-B	At Buoy 5	43	N/A[c]
4	4-T	Mid-channel, 1000 feet west of Million Dollar Bridge	1.5	N/A[c]
4	4-B	Mid-channel, 1000 feet west of Million Dollar Bridge	43	530
5	5-T	West end of Chandlers Dock	1.5	910
5	5-B	West end of Chandlers Dock	41	310
6	6-T	Mid-channel between stations 5 and 7	1.5	720
6	6-B	Mid-channel between stations 5 and 7	40	340
7	7-T	Atkins Buoy and the Sailboat Marina	1.5	370
7	7-B	Atkins Buoy and the Sailboat Marina	10	440
8	8-T	East end of the Drydock	1.5	600
8	8-B	East end of the Drydock	49	160
9	9-T	Mid-channel between stations 8 and 10	1.5	800
9	9-B	Mid-channel between stations 8 and 10	40	130
10	10-T	Off public Dock	1.5	360
10	10-B	Off public Dock	21	320
11	11-T	South of Pomroy Rock	1.5	230
11	11-B	South of Pomroy Rock	30	Not Provided
12	12-T	North: 43-40-60.3; West: 70-13-65.4	1.5	Not Provided
12	12-B	North: 43-40-60.3; West: 70-13-65.4	43	Not Provided
13	13-T	Spring Point Breakwater	1.5	Not Provided
13	13-B	Spring Point Breakwater	31	Not Provided

[a] Water samples collected from these locations on October 3 and 5 have been archived.
[b] Not applicable since station was deleted due to sampling inaccessibility.
[c] Data for stations 3-B and 4-T were misplaced by the laboratory.

4.5.2 Upper Fore River Water Samples

Twenty water quality stations were established above the Interstate 295 Bridge on the Fore River, Stroudwater River and Long Creek (USFWS 1997c). Sampling station locations are shown in Exhibit 4-33. Samples were generally collected in shallow locations from a shallow draft boat (e.g., a canoe). Water samples were taken approximately one foot below the surface. The samples were collected by disturbing surface sheens present, lowering a one-liter sample bottle enclosed in a zip-loc bag below the surface of the water, opening the bag and bottle lid, collecting the sample, closing the lid and bag, and bringing the sample up to the canoe. Samples were collected on September 30, October, 1, and October 4, 1996. September 30 samples (except for one sample collected from Thompson Point Cove) and all October 1 samples were analyzed by Arthur D. Little, Incorporated, according to a modified EPA 8270 protocol (i.e. GC/MS with single ion monitoring and quantification of alkylated homologs). All other samples were archived. Analytical results from the September 30 and October 1 water sampling effort are provided in Exhibit 4-34.

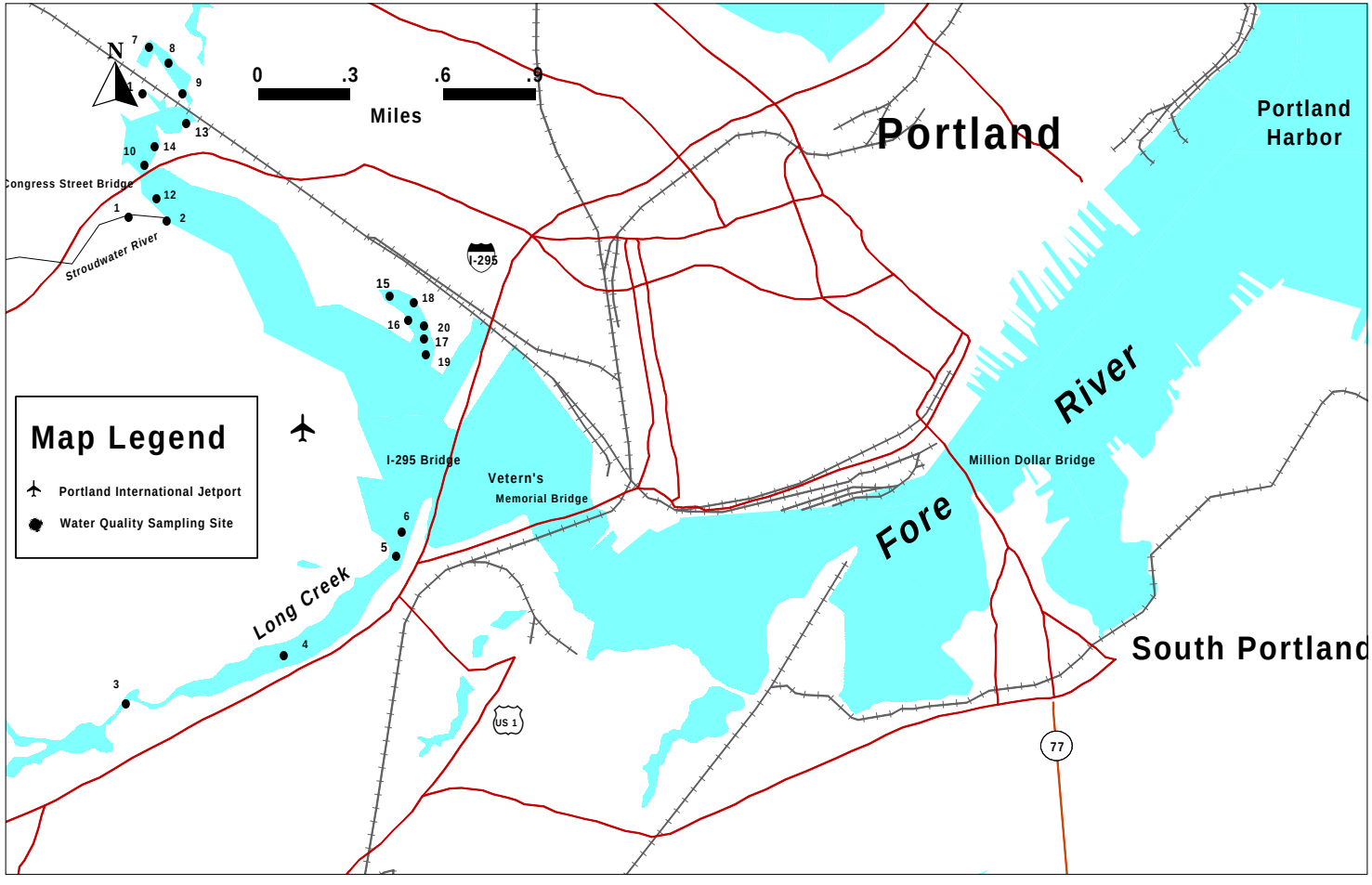
4.5.3 Oil Fingerprinting Analysis of Water Samples

Oil fingerprinting analysis of analyzed water samples was conducted by ADL (1997). All water samples contained a mixture of petrogenic and pyrogenic PAHs with most samples having between 70 and 95 percent petrogenic PAHs. Two samples, FRS-6 and SR-1, have substantially higher levels of pyrogenic PAHs, 75 percent and 58 percent respectively, and appear to contain a weathered creosote PAH signature. The biogenic PAH contribution for these two samples is also higher than the other samples, at approximately 1 percent.

Most of the double source ratio plots for the waters are either within the *Julie N* oil ellipses or above and to the right (Figure 12, Appendix V). This result indicates that the PAHs from samples with double ratios within the *Julie N* ellipses are likely from a *Julie N* source. However as PAHs weather over time, the source ratios tend to migrate above and to the right because the alkyl phenanthrenes weather slightly faster than the alkyl dibenzothiophenes. Since the PAHs in the water samples would be expected to be more weathered or "water washed," it is possible that the samples with source ratios above and to the right of the *Julie N* ellipses could represent contributions from more extensively weathered *Julie N* oil. These samples have petrogenic to non-petrogenic ratios similar to those found within the *Julie N* ellipses, and although allocated as other petrogenic sources, may be conservatively viewed as related to *Julie N* oil. Several water samples, FRS-3, FRS-1, FRS-6, 2B-B1, and 2-T-B1 plot well away from the *Julie N* oil ellipses, indicating an influence from other "non-*Julie N*" petroleum sources.

Exhibit 4-33

Upper Fore River Water Quality Sampling Stations
(Based on USFWS 1997c)



Use Only As A General Reference

Graphic Does Not Represent Precise Locations

Exhibit 4-34

TOTAL PAH CONCENTRATIONS IN UPPER FORE RIVER AREA WATER SAMPLES COLLECTED BETWEEN SEPTEMBER 30 AND OCTOBER 1, 1996 (USFWS 1997a; ADL 1997)

Station	Sample	Sample Location	Sample Date	Total PAH (ng/L)
1	SR-1	Stroudwater River (upstream sample)	9/30/96	433
2	SR-2	Stroudwater River (downstream sample)	9/30/96	1,229
3	LC-1	Long Creek, near Route 9	10/1/96	1,557
4	LC-2	Long Creek, middle	10/1/96	813
5	LC-3	Long Creek, confluence with Fore River	10/1/96	598
6	LC-4	Long Creek, 200 feet up from runway light bridge	10/4/96	N/A[a]
7	FRS-1	Fore River Sanctuary, winding way culvert	9/30/96	1,226
8	FRS-2	Fore River Sanctuary, railroad	9/30/96	1,394
9	FRS-3	Fore River Sanctuary, culvert	9/30/96	1,012
10	FRS-4	Fore River Sanctuary, above Congress Bridge	9/30/96	1,037
11	FRS-5	Tow Path Tributary	9/30/96	839
12	FRS-6	Capisic Brook	9/30/96	605
13	FRS-7	Fore River Sanctuary, Next to Routes 9/22 Bridge	10/4/96	N/A[a]
14	FRS-8	Fore River, far side of railroad grade, inside boom	10/4/96	N/A[a]
15	TPC-1	Thompson Point Cove, near railroad bed	9/30/96	50,787
16	TPC-2	Thompson Point Cove, middle (low tide)	9/30/96	N/A[a]
17	TPC-3	Thompson Point Cove, confluence with Fore River (low tide)	9/30/96	32,997
18	TPC-2B	Thompson Point Cove 2, high tide sample	10/1/96	2,425
19	TPC-3B	Thompson Point Cove, sample 3 (high tide)	10/1/96	1,558
20	TPC-4	Thompson Point Cove, down from pump house	10/4/96	N/A[a]

[a] Water sample was not analyzed.

4.6. SOCIOECONOMIC IMPACTS

Socioeconomic impacts caused by the *Julie N* oil spill are addressed in the Lost Use Valuation Report (Appendix T). This report is a revised version of the Economic Data Collection Report. The Lost Use Valuation Report summarizes data collected on public use disruptions caused by the *Julie N* oil spill. Economic impacts to private parties are the subject of private claims against the Responsible Party, and are therefore outside the scope of this preassessment study.

This study underestimates total lost use because it focuses only on direct impacts for which at least some measurable data exist. Passive use losses, such as those associated with lost opportunities for experiencing the usual activities of a working harbor, viewing wildlife, or enjoying scenic habitats and harbor views, have not been included. It should also be stressed that the people of Maine have a very strong commitment to their communities and the natural

environment. The *Julie N* oil spill had an emotional impact on people who reside and work within the Casco Bay watershed, if not the entire State of Maine. This impact cannot be quantified at a reasonable cost, but its existence should not be ignored.

Impacts to the public use of spill-contaminated resources in the Fore River/Portland Harbor and western Casco Bay areas were varied, increasing with proximity to the spill site (Million Dollar Bridge) and heavily contaminated areas (i.e. portions of Portland Harbor and the Fore River). Exhibit 4-35 provides a summary of disrupted public uses identified in the Lost Use Valuation Report.

Exhibit 4-35

SUMMARY OF HUMAN USE LOSSES CAUSED BY THE *JULIE N* OIL SPILL (IEc 1998)

Resource Impacted	Disruption
Ferry Boat Trips	Vessel closure of harbor resulted in 3 day disruption to Prince of Fundy Cruises Limited service between Portland and Yarmouth, NS. 250 lost ferry boat trips 2,700 diminished use trips
Wayneflete School Trail Activities	Signage posting at Wayneflete School Trail from September 27, 1996 to June 30, 1997. 1,380 lost trips 1,380 diminished use trips
Party/ Charter Boat Recreational Fishing Trips	Fishing closures impacted various fisheries/geographic areas within spill impact zone from September 27th - November 15th. Approximately 124 party/charter boat recreational fishing trips lost.
Recreational Boating Trips	Recreational boating restricted at marinas/mooring areas located within spill safety zones. Cumulative potential lost boating trips (person days) estimated to be 11, 737 trips. Cumulative adjusted lost boating trips (person days) estimated to be 4,862 trips, or 41 percent of total potential lost boating trips (person days).
Tour Boat Trips	Educational tour boat trips to House Island canceled. Approximately 300 lost tour boat trips of secondary school students resulted.
Whale Watching Trips	Approximately 225 lost whale watching trips.

Casco Bay Line Ferries were not impacted since the ferry terminal in Portland Harbor is located outside of the spill response safety zones established by the U.S. Coast Guard. Service provided by the Prince of Fundy Cruises Limited ferry, *Scotia Prince*, linking Portland to Yarmouth, Nova Scotia, was seriously disrupted from September 27-29. The Portland International Ferry Terminal, the *Scotia Prince* berth in Portland Harbor, is located within the safety zone, resulting in 250 lost ferry boat trips and 2,700 diminished use ferry boat trips.

Signage at the Wayneflete School Trails warned the public of the oil impacted marshes until June 30, 1997. Postings resulted in an estimated 1,380 lost trips and 1,380 diminished use trips.

The spill occurred as the marine sport-fishing season was nearing its regional closure for the season (i.e., normally on Columbus Day, October 14th). Patronage of party/charter boat recreational fishing businesses was lighter than normal, because of the spill; 124 party/charter boat recreational fishing trips were lost in late September and October.

The oil spill caused closures to both commercial and sport marine fisheries. Closures of marine fisheries are detailed in Exhibit 4-36 (MDMR 1996). A time-series collection of marine fisheries closure maps can be found in Exhibit 4-37 (NOAA 1996).

The Casco Bay recreational boating season generally ends in late September; with the season extending for another month in the Fore River/Portland Harbor area. Recreational boats staged at marinas located outside the spill Safety Zones were generally not affected by vessel traffic restrictions. Marinas and mooring areas located within the safety zones (i.e., Portland Harbor/Fore River Areas) experienced closures, ranging from several days in duration to up to six weeks (in the case of Merrill's Marina). We estimated 11,737 potential lost boating trips could have been taken had the spill not occurred. An estimated 4,862 adjusted (for weather) lost boating trips resulted from these closures. Total adjusted lost boating trips are 41 percent of the potential total lost boating trips that could have otherwise occurred during that time period had there not been an oil spill.

Educational tour boat trips to House Island for approximately 300 secondary school students were canceled following the spill. Also, an estimated 225 whale watching trips were lost during spill response/cleanup operations in late September and October.

Exhibit 4-36

MARINE FISHERIES CLOSURES
***JULIE N* OIL SPILL, PORTLAND, MAINE - 9/27/96**
RULE REPEALS AND PROMULGATIONS (MDMR 1996e)

9/27/96	#5000 - New Rule - All Marine Species Fore River (Spring Point, South Portland to Fish Point, Portland). *(Initial closure to harvest of all species in the immediate vicinity of spill)*
9/28/96	#5001 - New Rule - Shellfish only Cape Elizabeth to Parker Point, Yarmouth *(Initial closure to harvest of shellfish in portions of Casco Bay)*
9/28/96	#5002 - New Rule - All Marine Species Outside Fore River (Spring Point, South Portland to Waits Point, Falmouth) *(Initial closure to harvest of all species outside the immediate vicinity of spill)*
9/30/96	#5002 - Repeal and Promulgation - All Marine Species Expanded closed area (Portland Head Light, South Portland to Waits Point, Falmouth) *(Expansion of the closure to harvest of all species outside the Fore River, extended the closure southward)*
10/4/96	#5002 - Repeal and Promulgation - All Marine Species Exception: Marine Worms outside the Fore River Reduced the closure to Portland Head Light, South Portland to Mackworth Island, Falmouth (are including Peaks and Great Diamond Islands) *(allowed for the harvest of Marine worms in the closure outside of the Fore River)*
10/7/96	#5001 - Repeal - Shellfish Only *(Opened the outer portions to shellfishing)*
10/10/96	#5002 - Repeal and Promulgation - All Marine Species Exception: Lobsters and Marine Worms outside the Fore River Boundaries remain the same as 10/4/96 *(Allowed for the harvest of Marine worms and Lobsters in the closed area outside of the Fore River)*
10/12/96	#5000 - Repeal and Promulgation - All Marine Species Exception: Lobsters may be harvested in the Fore River *(Allowed the harvest of Lobster within the entire Fore River)*
10/19/96	#5000 - Repeal and Promulgation - All Marine Species Exception: Lobster may be harvested outside of a line from the Coast Guard Base Pier to the Fish Pier. *(Decreased area available for harvesting Lobster in the Fore River)*
10/31/96	#5002 - Repeal *(opened outer portion to harvest of all marine species)*
10/31/96	#5000 - Repeal and Promulgation - All Marine Species Reduced closure zone to all marine species to a line from the Coast Guard Base Pier to the Fish Pier. *(Opened outer portions of the harbor to other species)*
11/12/96	#5000 - Repeal and Promulgation - All Marine Species Exception: Lobsters may be harvested in the closed area (a line from the Coast Guard Base Pier to Fish Pier). *(allowed harvest of Lobster in the inner Fore River)*
11/15/96	#5000 - Repeal - All Marine Species *(Opened the entire Fore River to the harvest of any marine species)*

JULIE N Incident **Exhibit 4-37**

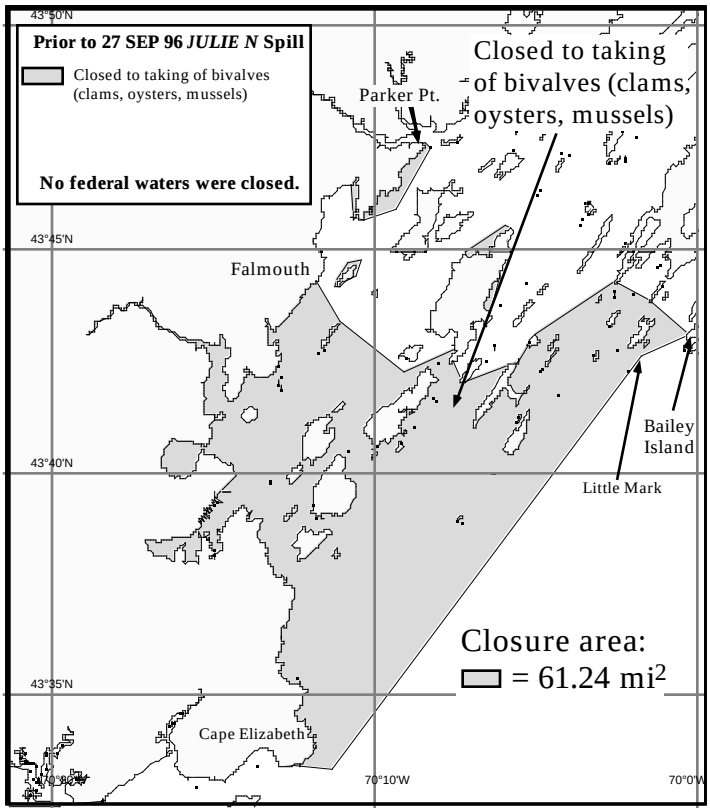
Fisheries Closure Composite

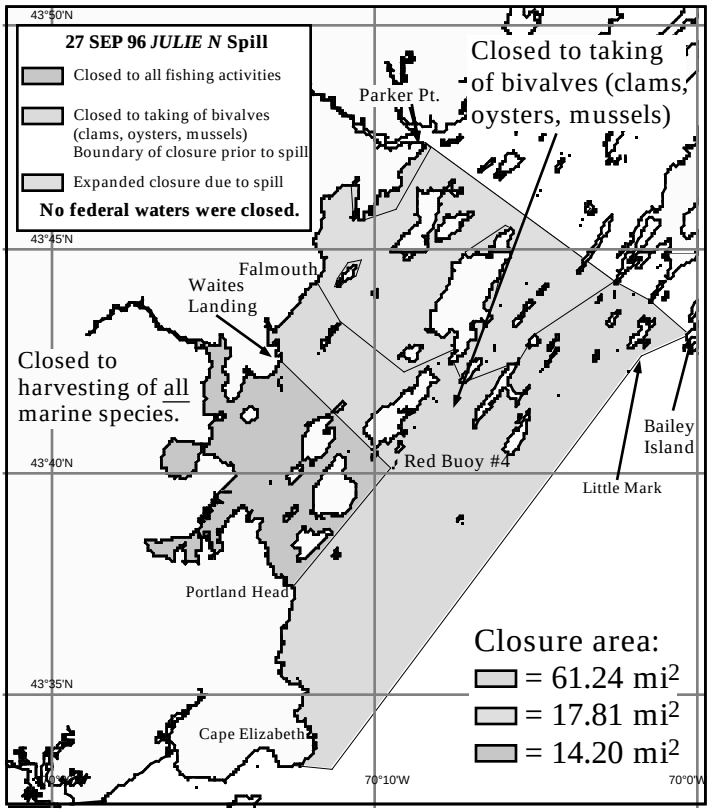
Date/Time: 08 OCT 96

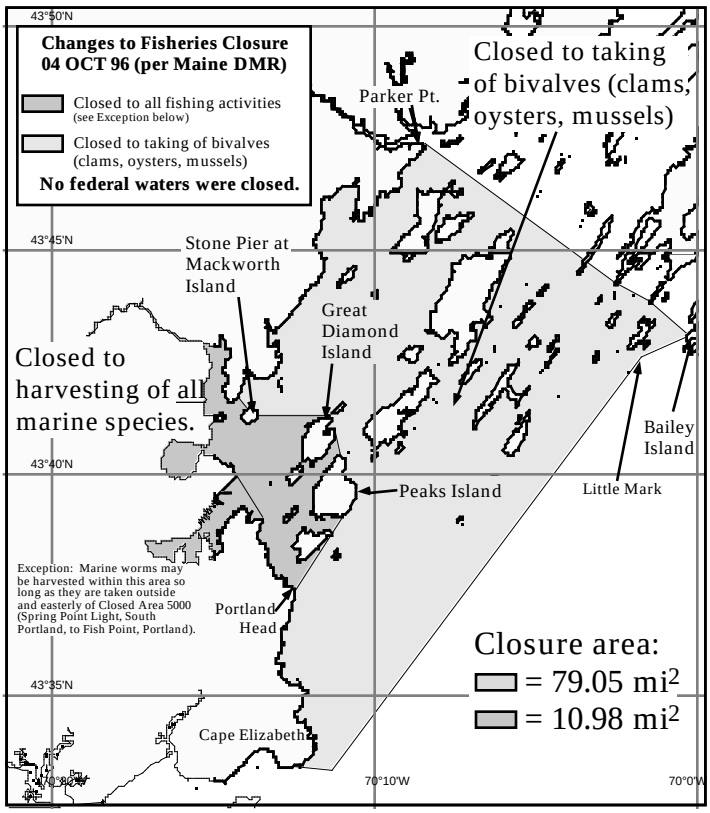
prepared by NOAA
based on information provided by Maine Department of Marine Resources and USCG

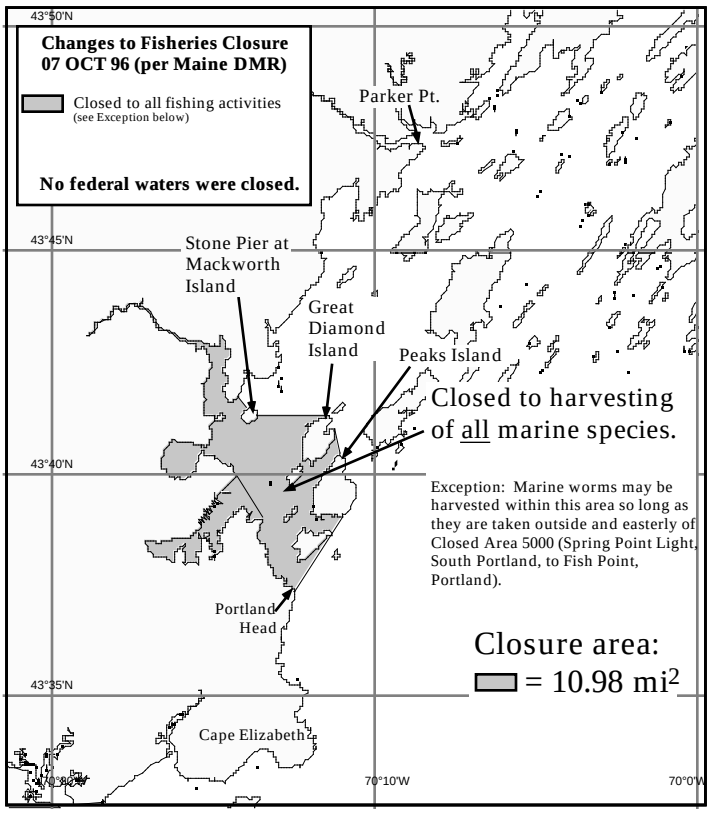
1 in = 4.92 mi

USE ONLY AS A GENERAL REFERENCE Graphics do not indicate precise amounts or locations of oil.









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