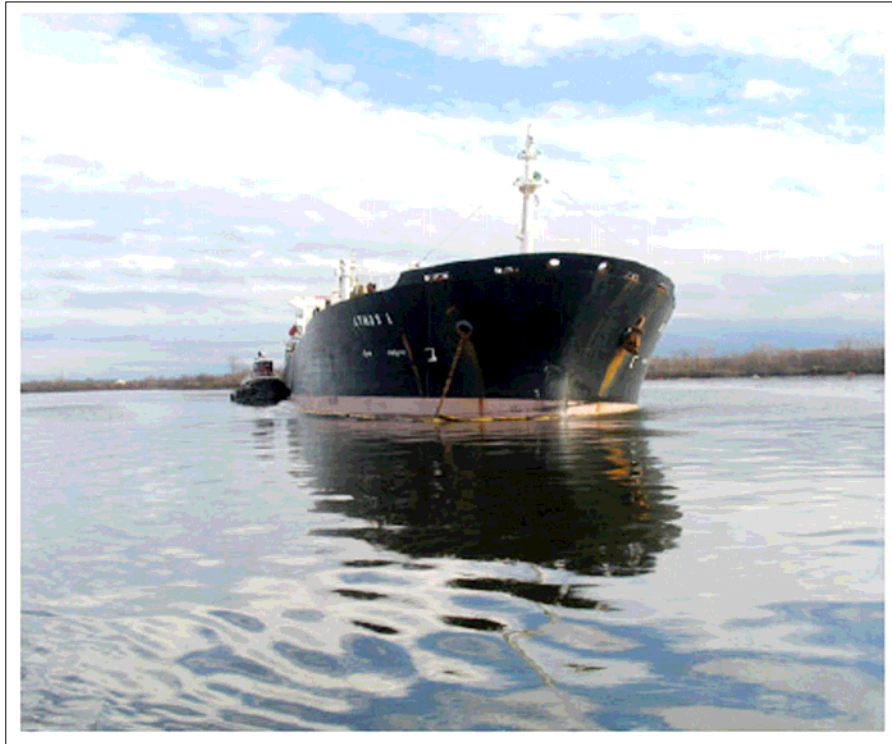


Final Preassessment Data Report *M/T ATHOS I* Oil Spill, Delaware River

June 2006



U.S. Department of Commerce
National Oceanic and Atmospheric Administration

State of New Jersey
Department of Environmental Protection

Commonwealth of Pennsylvania
Department of Conservation and Natural Resources
Department of Environmental Protection
Fish and Boat Commission
Game Commission

State of Delaware
Department of Natural Resources and Environmental Control

U.S. Department of the Interior
U.S. Fish and Wildlife Service

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1.0 INTRODUCTION

On 26 November 2004, the *M/T ATHOS I (Athos)* struck a large, submerged anchor while preparing to dock at a refinery in Paulsboro, New Jersey. The anchor punctured the vessel's bottom, resulting in the discharge of nearly 265,000 gallons of crude oil into the Delaware River and nearby tributaries.

Federal, state, and local agencies responded to the incident to supervise and assist in clean-up and begin assessing the impact of the spill on natural resources. The U.S. Coast Guard (USCG), States of New Jersey and Delaware, and Commonwealth of Pennsylvania created a Unified Command for directing clean-up efforts. The National Oceanic and Atmospheric Administration (NOAA), U.S. Fish and Wildlife Service (USFWS), and natural resource agencies within Delaware, New Jersey, and Pennsylvania (collectively referred to as the natural resource trustees) began collecting "preassessment" data to determine whether natural resource damage assessment (NRDA) actions under the Oil Pollution Act of 1990 (OPA) (33 U.S.C. §2706(b)) were justified and make preliminary determinations regarding the type of injury assessment and restoration actions that might be pursued.

This preassessment data report presents the preliminary information and data collected by the natural resource trustees as part of the preassessment efforts. The trustees will use this information to determine the type of injury assessment efforts required to quantify the nature and extent of injuries and scale of appropriate restoration actions.

2.0 OVERVIEW OF THE INCIDENT AND PREASSESSMENT ACTIVITIES

The *Athos* is a 750-foot, single bottom, double-sided tanker that was built in 1983. At the time of the incident, the vessel was registered under the flag of Cyprus, owned by Frescati Shipping Company, Ltd., and operated by Tsakos Shipping & Trading, S.A.

The *Athos* departed Venezuela for the Citgo Asphalt Refinery in Paulsboro, New Jersey (Figure 1) on 20 November 2004, carrying approximately 13 million gallons of crude oil. At approximately 9:30 pm on 26 November 2004, tug operators assisting the *Athos* with docking at the refinery notified the USCG that the tanker was leaking oil. The vessel had struck several submerged objects (Figure 2) while maneuvering through Anchorage #9 to its berth. Within minutes, the ship lost power and listed approximately eight degrees to the vessel's port side (Figure 3).

Surveys of the river bottom following the incident found several submerged objects in the area, including an 18,000 pound anchor, large concrete block, and pump casing. The USCG's investigation of the incident determined that the anchor punctured the vessel's number seven center cargo and port ballast tanks (USCG 2006). The bulkhead between the cargo and ballast tanks was also damaged, allowing product to migrate into the ballast tank and then into the river (USCG 2005).



Figure 1. Approximate location of the *Athos* oil spill incident on the Delaware River. East of the River, Camden, Gloucester, and Salem counties are in New Jersey. West of the River, Philadelphia and Delaware counties are in Pennsylvania; New Castle County is in Delaware.



Figure 2. Submerged objects recovered from the vicinity of the *Athos* grounding location.



Figure 3. Aerial view of the *Athos* listing to the port side following grounding incident.

The Unified Command initially estimated that 30,000 gallons of oil spilled into the River. This estimate was revised to 473,500 gallons based on “worst-case” assumptions once the vessel was stabilized several days after the incident. Following a more comprehensive analysis after lightering of the remaining oil, the USCG provided a final estimate of 264,335 gallons that spilled into the Delaware River.

At the time of the incident, the tide was incoming, and the current was approximately one and a half to two knots (USCG 2005). Within the first few hours, thick oil covered the River and moved upriver with the flood tide to about the Walt Whitman Bridge, approximately six miles north (Figure 1). Over the following weeks and months, oil from the ruptured tanker spread downriver, exposing natural resources over 115 river miles of the Delaware River (280 miles of shoreline), as well as its tributaries, from the Tacony-Palmyra Bridge to south of the Smyrna River in Delaware. Key resources exposed to the spilled oil include shorelines (marshes, sandy beaches, tidal flats, etc.), aquatic organisms (fish, shellfish, etc.), birds and other wildlife that use the Delaware River and Bay (Figure 4), and recreational use. The incident also forced the USCG to close the Delaware River to commercial traffic for over a week, and submerged oil resulted in contamination of water intakes and the closure of the Salem Nuclear Power Plant.



a.



b.



c.



d.

Figure 4. Key resources exposed to *Athos* oil. a. Heavy oil stranded in the intertidal area, south side of Tinicum Island. b. Heavily oiled rip-rap shoreline at Fort Mifflin, near Philadelphia, PA. c. Heavily oiled coarse substrate beach. d. Oiled waterfowl.

Under OPA, state and federal agencies are designated as natural resource trustees, responsible for assessing natural resource losses and restoring those losses to baseline conditions, that is, the conditions that would have existed had the incident not occurred. Regulations promulgated under OPA provide a framework for conducting a natural resource damage assessment (NRDA), including preassessment, restoration planning, and restoration implementation (15 C.F.R. Part 990). Funds to assess losses and to plan and implement appropriate restoration are provided by either the responsible party (RP) or, if an RP does not exist or exceeds its limit of liability, the Oil Spill Liability Trust Fund established under OPA.¹

The trustees and representatives of the ship owner and ship operator initiated preassessment activities under OPA on 27 November 2004. A “cooperative” work group was formed,

¹ Under OPA, the limit of liability is established by the gross tonnage (GT) of the vessel. The GT of the *Athos* is 37,895 GT. Accordingly, the limit of liability is \$47,474,000 (\$1,200 per GT) (USCG 2005).

consisting of ship owner/ ship operator representatives (Entrix, Inc. and Polaris Applied Sciences, Inc.), the U.S. Department of Commerce, NOAA; U.S. Department of the Interior, USFWS; Pennsylvania Department of Conservation and Natural Resources, Department of Environmental Protection, Game Commission, and Fish and Boat Commission; New Jersey Department of Environmental Protection (NJDEP); and Delaware Department of Natural Resources and Environmental Control (DNREC). While the work group was a cooperative process, the trustees maintained formal decision-making authority

Specific preassessment activities included shoreline (aerial and ground) and resource (*e.g.*, bird and wildlife, horseshoe crab) surveys and ephemeral data collection (*e.g.*, water, sediment, and fish and shellfish tissue samples). This report describes these preassessment data collection efforts, and provides laboratory results and supporting documentation in Appendices A through I. The full laboratory reports, including quality control and quality assurance documentation (*e.g.*, matrix spike, surrogate recovery), are also available upon request.²

The preassessment data presented in this report are used by the trustees to make an initial determination as to whether natural resources or services have been injured or are likely to be injured by the release. If preassessment efforts indicate natural resources may have been injured, the trustees have authority to pursue more detailed studies to quantify the nature and extent of losses and implement appropriate restoration to compensate for those losses.

3.0 CHARACTERISTICS OF THE SPILLED PRODUCT

The *Athos* was carrying a heavy Venezuelan crude oil (Bachaquero), a slightly buoyant, very viscous, and sticky cargo that is heated during transport. This oil weathers slowly, has high asphalt content, and readily forms tar balls (Figure 5). The general physical properties of Venezuelan crude oil are provided in Meyers (2004) and summarized in Table 1.

Several source oil samples were taken from the *Athos* for analyses to identify the exact composition of the oil and allow for comparison of chemical “fingerprints” to oil collected in the Delaware River environment. The USCG collected source oil samples on 28 November 2004 and 3 December 2004, both from tank center seven, the compromised compartment. The 28 November samples were sent to:

- (1) Geochemical and Environmental Research Group (GERG) at Texas A&M University for analysis of polycyclic aromatic hydrocarbons (PAHs) and biomarkers (*e.g.*, steranes, diterpanes, and triterpanes);
- (2) B&B Laboratories (an affiliate of TDI-Brooks International, Inc.) in College Station, TX, for analysis of PAHs and trace metals; and
- (3) Lancaster Laboratories in Lancaster, PA, for analysis of aromatics.

The 3 December 2004 samples were archived at B&B Laboratories.

² Documents will be available on-line at <http://www.darrp.noaa.gov/northeast/athos/admin.html>.



a.

b.

Figure 5. Example of asphalt tar mats (a) and tar balls (b) that washed up on the shorelines following the *Athos* incident.

Results of the analyses of the 28 November 2004 sample are presented in Appendix A. In general, the data and analyses indicate that the *Athos* oil is composed of large amounts of asphaltenes and other high molecular weight compounds. The PAH content is low (0.5 percent), and the oil has a very low dissolved fraction. The significant oil-fingerprinting biomarker compounds, hopanes and steranes, were detected, but at naturally occurring very low levels.

Additional source oil samples were collected by NOAA on 6 December 2004 and 9 December 2004. These samples were sent to Louisiana State University (LSU) for fingerprinting analysis, as well as a determination of density, viscosity, evaporative weathering, and standard distillation curve analysis.

Table 1. Characteristics of Venezuelan crude oil (Table 14.1.1 in Meyers (2004)).

| Crude oil parameters: | |
|--|------|
| Density ($^{\circ}$ API) | 33.3 |
| Sulfur (% by weight) | 1.2 |
| Nitrogen (% by weight) | 0.12 |
| Vacuum residuum characteristics: (1000$^{\circ}$ F + [538$^{\circ}$ C +]) | |
| Yield (LV %) | 21.2 |
| Density ($^{\circ}$ API) | 10.9 |
| Sulfur (% by weight) | 2.8 |
| Nitrogen (% by weight) | 0.56 |
| Asphaltenes (% by weight) | 16.0 |
| Nickel + Vanadium (ppm) | 666 |
| Iron (ppm) | 5 |

Analytical results of the LSU source oil samples are also presented in Appendix A. In general, these samples displayed a fingerprint pattern similar to heavy crude oil (normal alkane ranges from nC-10 to nC-26), with the 9 December sample exhibiting a higher degree of weathering. The normal alkane distribution in oil contained few individual peaks and a large amount of unresolved hydrocarbons. The oil density of the samples was 0.943, 0.973, and 0.978 grams per milliliter (g/mL), lighter than both fresh water (1.00 g/mL), and oceanic seawater (1.025 g/mL). The viscosity was greater than 5,000 centistokes (cSt) at 100°F and at ambient water temperature greater than 50,000 cSt, meaning that the oil was very viscous and poured only at high temperature.

The fresh source oil was “evaporatively weathered” by heating it to 90°C under vacuum and less than three percent was lost by evaporation after four hours. Therefore, the weathered oil after evaporation was still expected to float (Appendix A).

On a wet weight mass basis, specific PAHs in the source oil represented 0.5 percent of the total oil mass (*i.e.*, average total PAH in source oil Tank 7 = 4596.2 ng/mg = 0.0046 g PAH/g neat \approx 0.5 percent). In other words, 99.5 percent of the source oil, on a mass basis, was something other than specific target PAHs. Presumably, this material was composed of asphaltenes and other high molecular weight refractory organics. These compounds have limited aqueous solubility and, therefore, toxicity, especially during cooler temperatures. Despite their limited solubility and aqueous toxicity, these compounds can be and apparently were present as a non-aqueous phase liquid that became dynamically attached to the bottom. When this happens, oxygen transfer to the bottom is inhibited and benthic aquatic life can smother and die.

Despite the low percentage of specific PAH compounds in the source oil, the PAHs in the oil were nevertheless inherently toxic and capable of causing harm to aquatic life. The estimated potency of the PAH mixture was 41.9 acute toxicity units and 213 chronic toxicity units (Appendix A).³ About 33 percent of this toxicity was due to naphthalenes, another 37 percent was due to fluorenes and phenanthrenes, 17 percent was due to dibenzothiophenes, and the balance was due to other specific PAHs (Appendix A).

4.0 PREASSESSMENT DATA COLLECTION METHODS AND RESULTS

The cooperative work group focused preassessment data collection efforts on four groups of resources: aquatic (including water column and benthic), shorelines, birds and wildlife, and recreation. Each of the resource categories was subject to a variety of sampling efforts and field surveys to characterize and document potential impacts resulting from the *Athos* incident. These efforts included:

³ The acute and chronic toxicity units (TUs) measure narcotic toxicity to benthic aquatic organisms exposed in sediment porewater. Using partition coefficients, the dissolved phase concentration of each PAH is calculated from the sorbed phase concentration. The acute TUs for each compounds are calculated as the ratio of the dissolved phase concentration to the acute narcotic toxicity. These are summed to give the overall acute TUs, and a chronic:acute ration applied to calculate overall chronic TUs. A TU greater than 1 indicates that the PAH exposure concentration in the sediment pore water exceeds the narcotic toxicity threshold for benthic aquatic organisms. A complete discussion of the equilibrium partitioning and narcotic toxicity approach can be found in DiToro *et al.*, 1991 and DiToro *et al.* 2000.

- Collection and analysis of water (surface and bottom) and sediment (intertidal and subtidal) samples;
- Observations of submerged oil;
- Collection and analysis of fish and shellfish tissue samples;
- Assessment of sediment toxicity;
- Surveys of shorelines;
- Surveys of birds and wildlife; and
- Interviews and surveys of recreation resources (*e.g.*, marina operators).

This section describes these preassessment data collection efforts.

4.1 Aquatic Resources

Numerous natural resources, including aquatic habitat and animals and the recreational uses they support, were exposed to the toxic and smothering effects of the oil discharged from the *M/T Athos*. Aquatic resources of concern include water column and benthic resources, ranging from interstitial sediment dwellers to larger mobile predators. Numerous adult and larval fish and shellfish are supported by the River, including the federally-endangered shortnose sturgeon (*Acipenser brevirostrum*) that winter in certain areas of the Delaware River. The waters around Little Tinicum Island are also known to contain high numbers of pre-spawn and spawning striped bass (*Morone saxatilis*) in April and May. The Bay supports commercial and natural oyster beds (*Crassostrea virginica*), commercial blue crab (*Callinectes sapidus*), horseshoe crab (*Limulus polyphemus*), and whelk (*Busycon* sp) fisheries, as well as a variety of recreational fisheries. Other important aquatic resources include red-bellied turtles (*Pseudemys rubriventris*) and eastern painted turtles (*Chrysemu picta picta*). Several rare tidal marsh plants are also found in the region, including wild rice (*Zizania aquatica*), waterhemp ragweed (*Amaranthus cannabinus*), Walter's barnyard grass (*Echinochloa walteri*), swamp-beggar-ticks (*Bidens bidentoides*), and marsh fleabane (*Pluchea odorata*). Bird and wildlife resources at risk include migrating marsh birds, egret and heron rookeries, eagles and osprey, and migratory shorebirds. The federally-threatened piping plover inhabits the Lower Delaware Bay. A variety of mink, otter, turtles, and terrestrial fauna use the affected area. Many types of recreation are also popular along the Delaware River in the areas affected by the spill, including waterfowl hunting, boating, fishing, and crabbing, as well as beach and other shoreline use.

4.1.1 Water Quality

In the first two weeks following the incident, 66 surface water and 13 bottom water samples were collected to characterize PAH concentrations. Surface water samples were collected on 27,

28, and 30 November: (1) at the Commodore Barry Bridge; (2) near Marcus Hook and in the Schuylkill River, PA; and (3) in and at the mouths of Big Timber, Woodbury, and Mantua Creeks, NJ. Surface and subsurface water samples were collected on 7 and 8 December: (1) upstream of the Tacony-Palmyra Bridge; (2) in the vicinity of Tinicum Island, PA; (3) in and at the mouths of Big Timber, Woodbury and Mantua Creeks, NJ; (4) Liston Point, DE, (5) the entrance to the Chesapeake and Delaware Canal; (6) the mouth of the Christina River, DE; and (7) at Marcus Hook, PA.

Surface water samples were collected by inserting a capped, one liter amber glass bottle immediately below the water's surface to avoid collecting whole oil on the surface layer. The bottle cap was removed underwater, the bottle allowed to fill and the cap replaced. Subsurface water samples were collected using a two and a half liter Go-Flo bottle with messenger. The bottle was lowered below the water's surface in a closed position and opened at approximately one meter off the bottom and 30 ft depth. Two one liter amber bottles were filled with the water from the Go-Flo bottle. The Go-Flo bottle was washed with Citra-Solv cleaner between samples and rinsed five times with distilled water. All water column samples were stored on ice, packed into a field cooler, and sent to B&B Laboratories for analysis under proper chain of custody. All samples were analyzed for total and individual PAHs. Lists of components included in the total PAH measurement for each lab are in Appendix A. Additional analyses included total suspended solids (TSS) for the samples collected on 7 and 8 December 2004, and volatile monocyclic compounds (VOC) in samples collected on 27 November 2004.

Figures 6a-c show the locations and total PAH results for surface and subsurface water samples collected in the Delaware River from 27 November to 8 December 2004.⁴ Laboratory data for concentrations of total and individual PAHs in the water samples are found in Appendix B. Total PAH in the samples ranged from 25 to 26,634 ng/L (parts per trillion) total PAHs.⁵ Using chronic toxicity thresholds (Neff *et al.* 2005), only two samples (at Marcus Hook and downstream of the mouth of the Schuylkill) had exceedances, both for alkylated chrysenes and alkylated phenanthrene/anthracenes.⁶ No volatile organics were detected within the reporting limits. Results of the TSS and VOC analyses are also presented in Appendix B. Because background levels of PAHs are found in many bays and estuaries, further analysis of these data would be necessary to determine the nature and extent of *Athos* oil in these water samples.

⁴ Coordinates were not reported for six samples: W-DER-01, W-DER-02, W-MAN-01, W-MAN-02, W-MAN-03, and W-MAN-04. Site descriptions and values for these samples were included in the sample log in Appendix B. Additionally, the reported coordinates for sample W-WOOD-05 place it in Big Timber Creek, while other WOOD samples are in Woodbury Creek.

⁵ Two values are given in the laboratory data for sample WMH #1-S (also listed as WMH #1-5). The two values are 26,634 ng/L and 293 ng/L, and only one sample is listed in the collection log with no explanation for the duplicate values. The remaining water samples were all below 5,000 ng/L total PAHs.

⁶ Analysis did not evaluate whether the PAHs in the water samples were in the dissolved phase or were associated with particulates. Aqueous toxicity thresholds are based on dissolved phase concentrations.

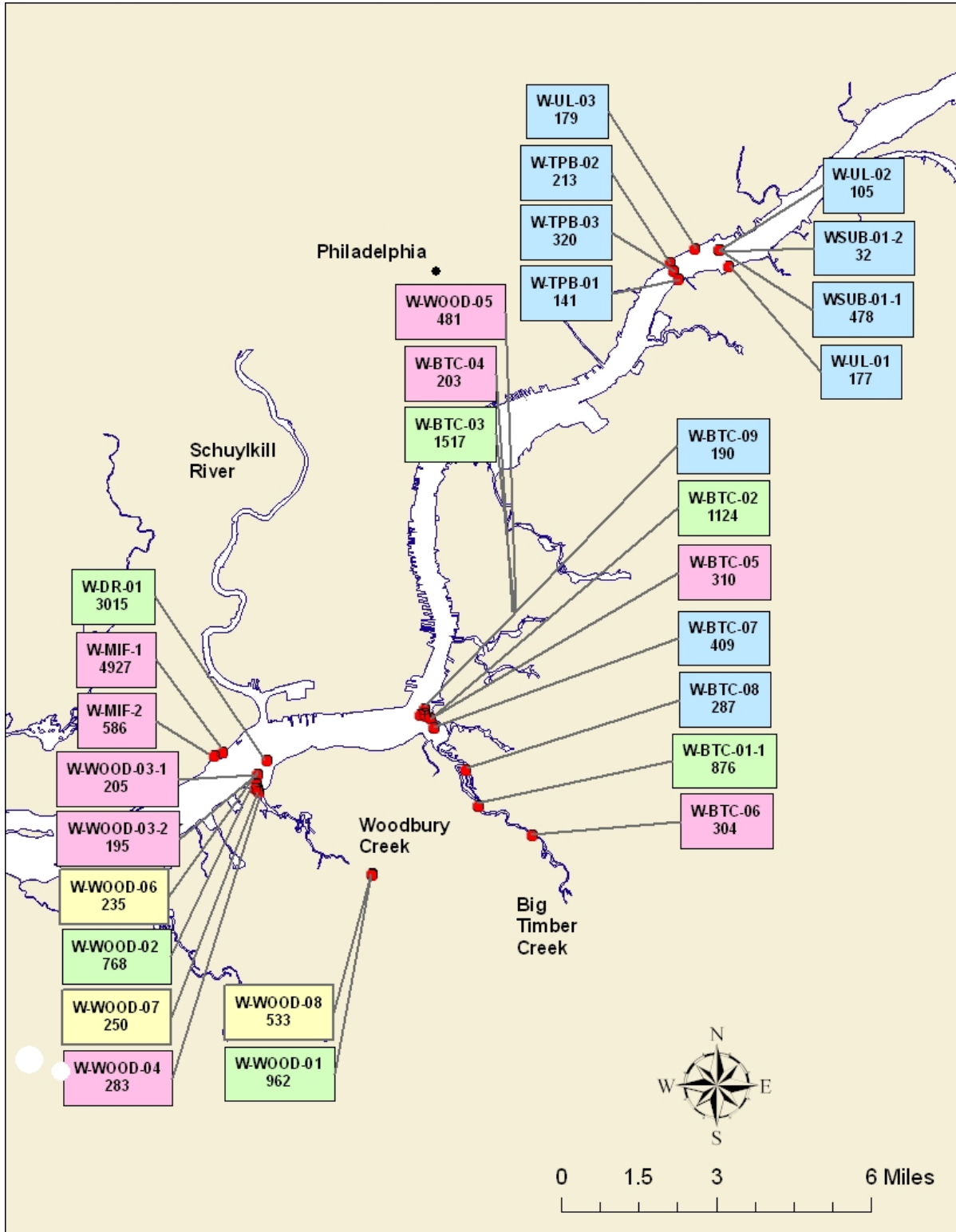


Figure 6a. Water sample locations in the upper Delaware River. Total PAH values (ng/L) are presented in boxes below sample identification code. Box color represents sample collection date: 28 November 2004 (green); 30 November 2004 (red); 7 December 2004 (blue); 8 December 2004 (yellow).

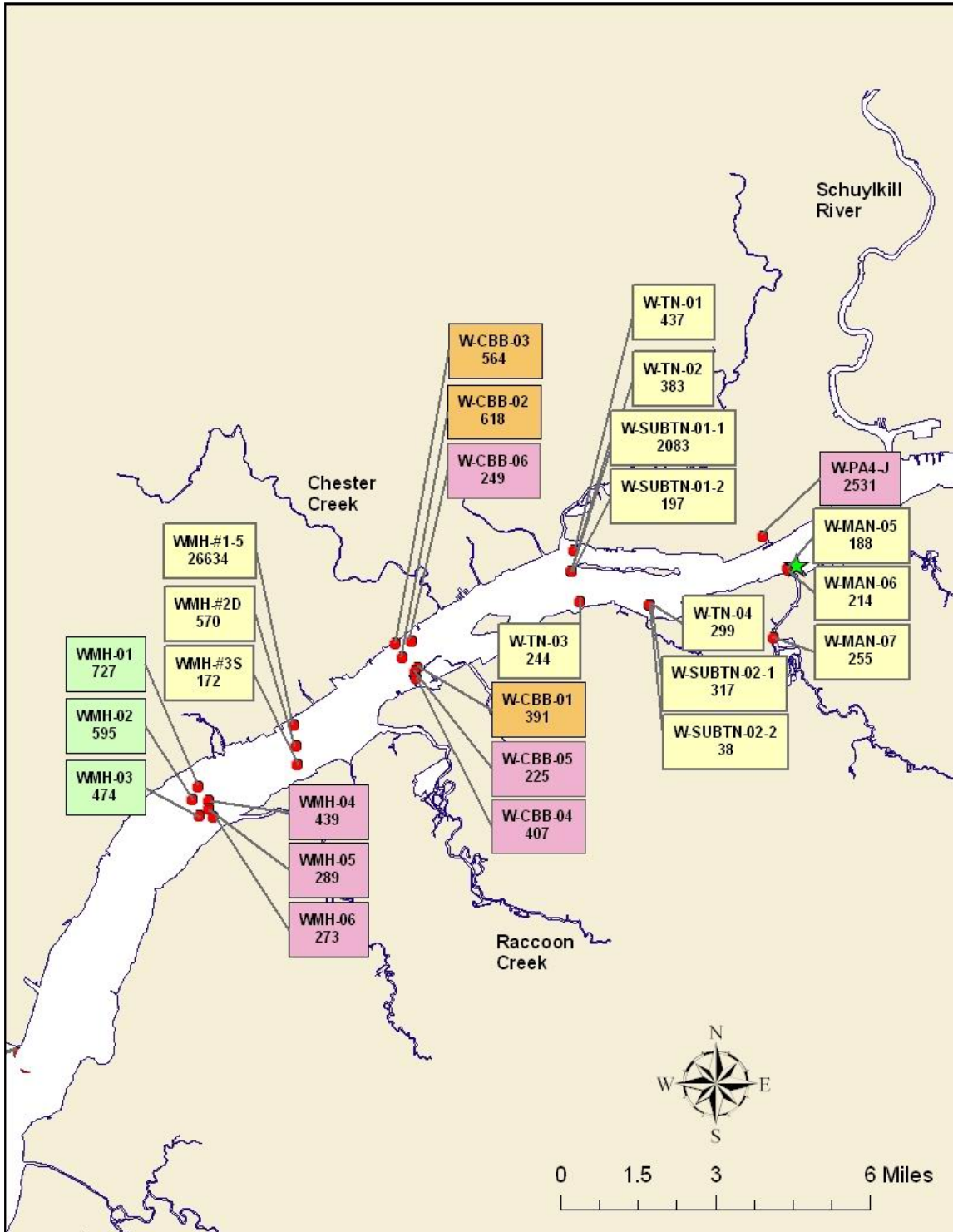


Figure 6b. Water sample locations in the middle Delaware River. Total PAH values (ng/L) are presented in boxes below sample identification code. Box color represents sample collection date: 27 November 2004 (orange), 28 November 2004 (green); 30 November 2004 (red); 8 December 2004 (yellow). The green star is the approximate spill location.

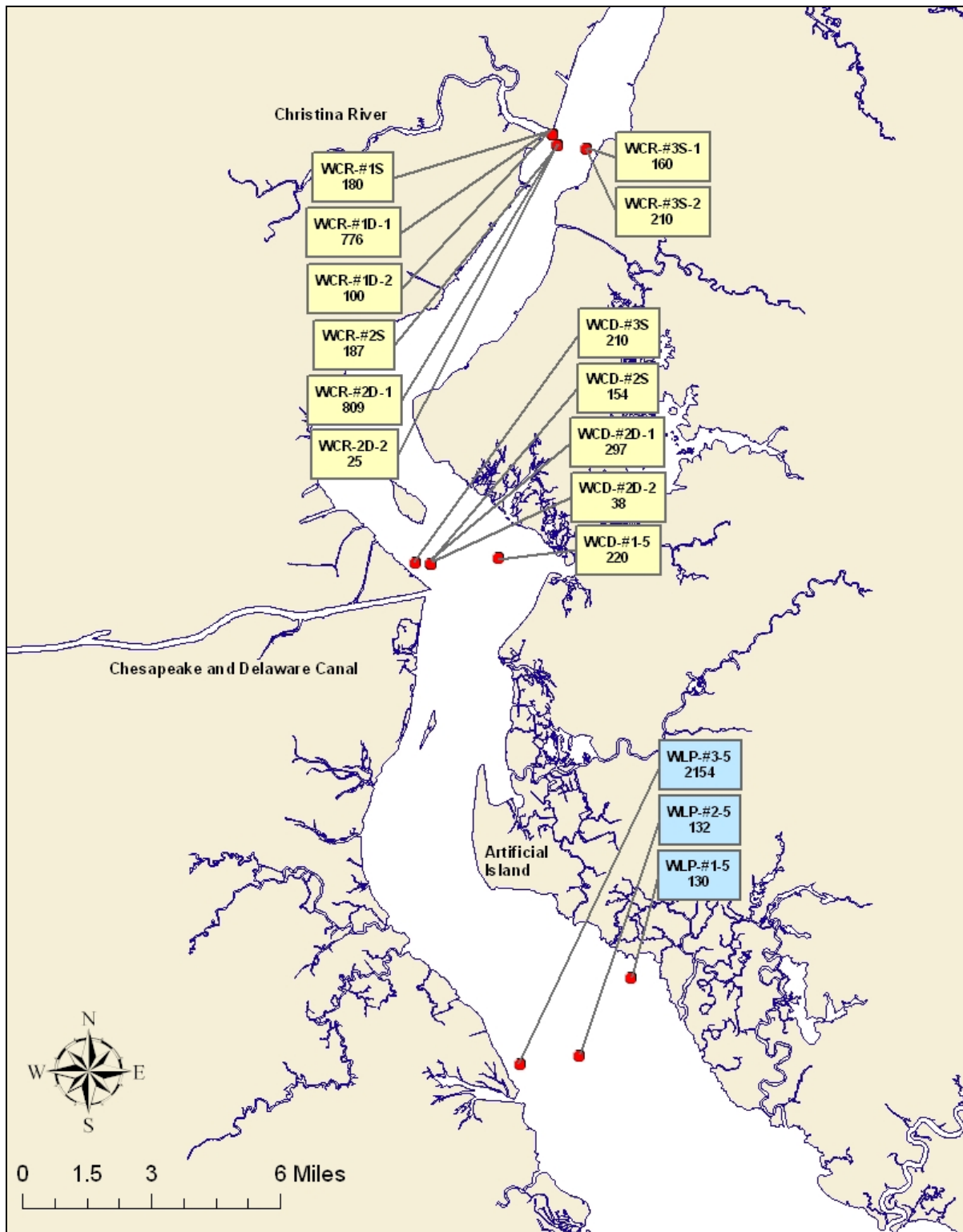


Figure 6c. Water sample locations in the lower Delaware River. Total PAH values (ng/L) are presented in boxes below sample identification code. Box color represents sample collection date: 7 December 2004 (blue) and 8 December 2004 (yellow).

4.1.2 Sediment Quality

While analyses of the *Athos* oil (see Section 3.0) indicated that the oil would float, oil was observed suspended throughout the water column and on the river bottom, and some shorelines were periodically re-oiled following cleanup activities. Response and preassessment strategies, therefore, included locating subsurface oil and collecting subtidal and intertidal sediment samples for analyses.

4.1.2.1 Subsurface Oil Observations

Subsurface oil was observed as pooled stranded oil and mobile suspended oil. Pooled stranded oil settled into natural depressions and was trapped due to the cohesive forces. Mobile suspended oil was negatively buoyant oil that was observed moving within the water column and/or rolling along the river bottom. Distinct assessment strategies were developed for the different types of subsurface oil.

Sonar, coring, sorbent probes, and the Vessel-Submerged Oil Recovery System (V-SORS) were used to search for pooled stranded oil in likely accumulation areas using US Army Corps of Engineers bathymetric maps of the channel and adjacent areas. The locations that were searched for stranded oil included:

- The shallow bay north of Tinicum Island, including two deep depressions,
- Four depressions on the south side of the channel across from Tinicum Island,
- Tinicum Range channel, and
- Shallows around Tinicum and Chester Islands.

Pooled stranded oil was found only at the collision site, in a trench six to eight feet wide, two feet deep, and 41 feet long. On 9 December 2004, a diver surveyed the trench area and measured the oil thickness as between one and a half and two feet deep. A second trench was also detected and estimated to be two feet wide by two feet deep by 15 feet long.

A sample of the oil from the trench floated in fresh water (density of 0.943 g/ml). It was tested for cohesiveness and found to adhere to sediments and did not refloat, even though it should based on density. It is believed the oil in the trench at the collision site was “injected” into the sediment under the pressure of the release and became immobile due to highly cohesive forces exerted by the viscous oil. Divers used viscous oil pumps to recover pooled oil from these two trenches on 12-16 December 2005.

The vertical distribution and the geographical extent of mobile suspended oil were tracked using a “snare sampler” device, consisting of an anchor, 50 feet of oleophilic snare on a rope, and a float (Appendix C), and crab pots with oil adsorbents attached. Snare samplers were deployed at various locations within the River and visually inspected for the presence of oil with depth, and the amount of oil on the snare (estimated as percent coverage).

The location of the snare samplers and results are presented in Appendix C. In general, most of the subsurface, mobile oil occurred several feet off the bottom, though small amounts of oil were present on the snares suspended in the middle and upper water column. Highest amounts of oil were detected around Tinicum Island. There were several stations with high oil coverage observed over the period 3-8 December. Many of the other snare samplers in the upper River were not oiled. The subsurface oil in the upper spill zone decreased significantly by 10 December 2004. The distribution of the subsurface oil in samples in the middle spill zone area was intermittent. No, or less than one percent, oil was observed on any of the snare samplers in the upper Delaware Bay. It appears that little to no subsurface oil had entered the upper Bay as of 11 December 2005.

Eight crab pots with oil adsorbents attached were deployed on 6 December 2004 by staff from New Jersey Bureau of Shellfisheries and Bureau of Marine Water Monitoring. The crab pots were generally located along the edge/slope of the shipping channel in water depths ranging from 12 to 30+ feet. No oil was observed on the pots either visually or through olfaction.

The submerged oil assessment report included in Appendix C provides additional details and findings of the initial efforts to assess the nature and extent of submerged oil.

4.1.2.2 Subtidal and Intertidal Sediment Sampling

The trustees and RP collected sediment samples to assess the potential injuries to benthic organisms. Benthic organisms may be injured due to smothering effects from oil or from toxicity due to PAH contamination in the oil.

Twenty-eight subtidal sediment samples were collected throughout the River and analyzed to characterize PAH concentrations. Subtidal sediment samples were collected on 9, 10, and 11 December at: (1) Liston Point, DE, (2) the entrance to the Chesapeake and Delaware Canal, (3) the mouth of the Christina River, DE, and (4) at Marcus Hook, PA (figures 7 a-b).

Subtidal sediments were collected with a petite Ponar sampling device. The Ponar descends through the water column and lands on the river bottom in an open position. Pulling up on the line attached to the Ponar closes the Ponar “jaws” collecting approximately one liter of sediment from the top few centimeters. The Ponar was opened in a stainless steel tray and the sediment scooped into a one liter bottle using a stainless steel spoon. All sampling equipment used during sampling was washed with Citra-Solv cleaner and rinsed with distilled water in between samples. All samples were stored on ice, packed into a field cooler, and sent to B&B Laboratories under proper chain of custody. All samples were analyzed for total and individual PAHs (modified USEPA Method 8270) (Appendix D).

Additional subtidal sediment samples were collected from three Delaware River Estuary sites included in NOAA’s National Status and Trends (NS&T) Program Mussel Watch Project to compare post spill and historical data. On 2 January 2005 samples were collected from Hope Creek, Arnolds Point Shoal, and Ben Davis Point Shoal.

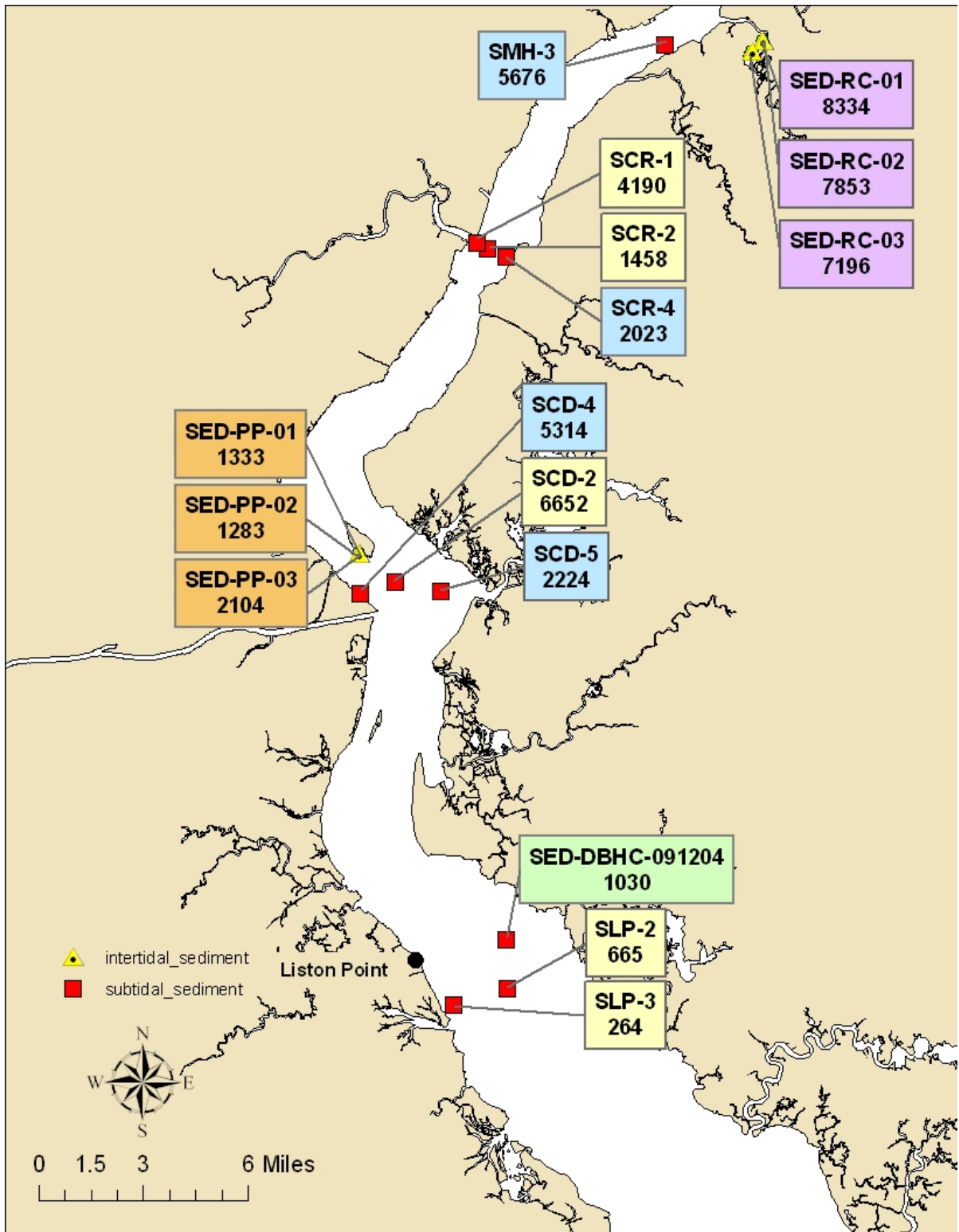


Figure 7a. Sediment samples and total PAHs (ng/g) in the lower Delaware River. Total PAH values (ng/g) are presented in boxes below sample identification code. Box color represents sample collection date: 9 December 2004 (green); 10 December 2004 (blue); 11 December 2004 (yellow); 14 December 2004 (purple); and 17 December 2004 (orange).

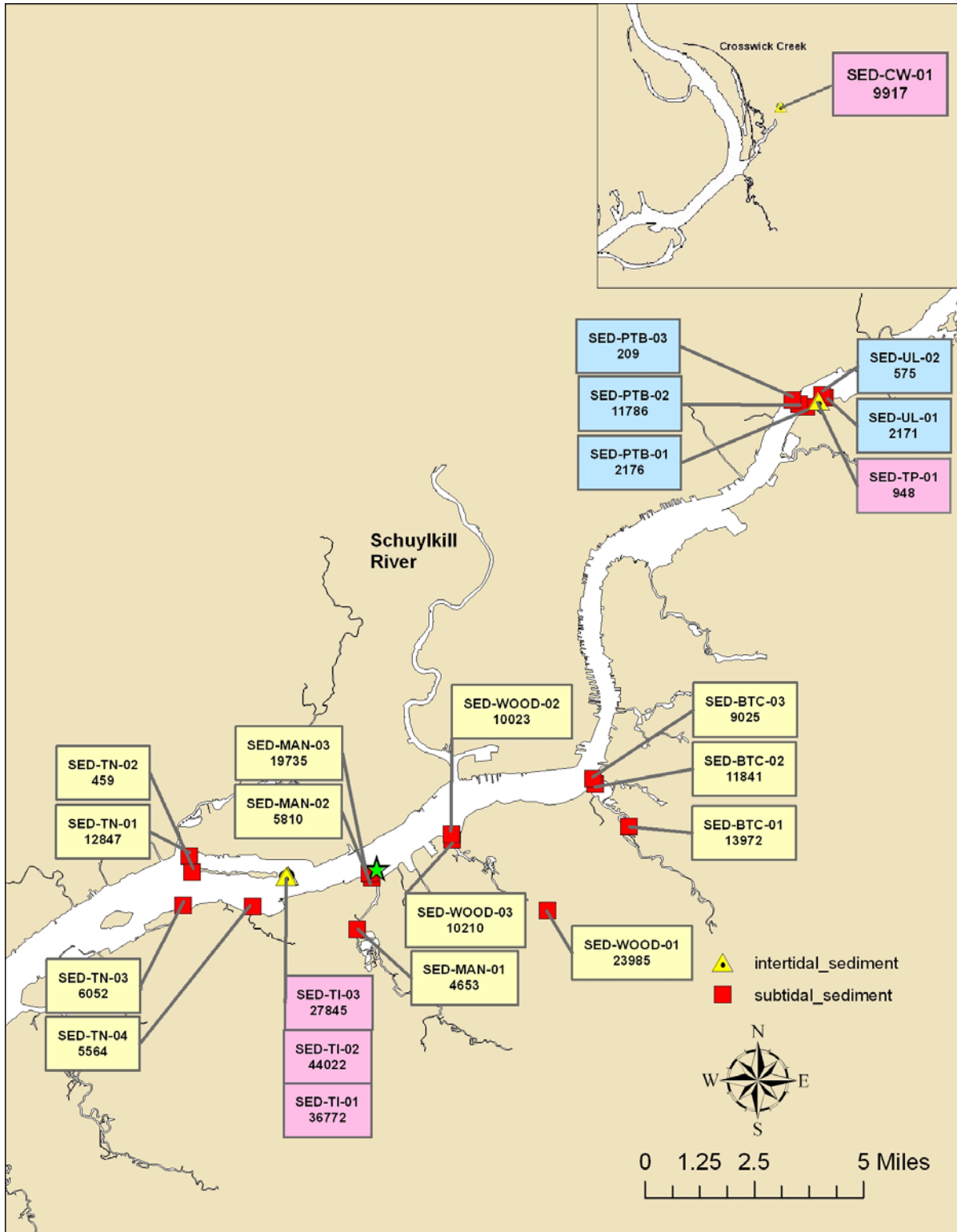


Figure 7b. Sediment samples and total PAHs (ng/g) in the upper Delaware River. Total PAH values (ng/g) are presented in boxes below sample identification code. Box color represents sample collection date: 10 December 2004 (blue); 11 December 2004 (yellow); and 15 December 2004 (pink). Green star represents approximate spill location.

Eleven intertidal sediment samples were collected from Crosswicks Creek, NJ, at the Tacony-Palmyra Bridge, in Raccoon Creek, NJ, and on Tinicum Island, PA intertidal areas of the Delaware River on 14, 15, and 17 December 2004 (Figures 7a-b). Samples were collected by scraping the top centimeter of sediment at sample sites with a stainless steel spoon and placing into a stainless steel mixing bowl. Once 500 ml of sediment had been collected, it was thoroughly mixed in the bowl and transferred to a one liter bottle. All samples were stored on ice, packed into a field cooler, and sent to GERG under proper chain of custody. All samples were analyzed for PAHs (modified USEPA Method 8270), alkanes, total organic carbon, and biomarkers to enable evaluation of the source of the PAHs in the sediments (Appendix E).

The locations and total PAH levels of subtidal and intertidal sediment samples collected in the Delaware River are shown in Figures 7a and 7b and presented in Appendices D (subtidal) and E (intertidal). Total PAH in subtidal samples ranged from 209 to 23,985 ng/g dry (ppb). Total PAH in samples from intertidal samples ranged from 948 to 44,022 ng/g dry. Because background levels of PAHs are found in many bays and estuaries, further analysis of these data would be necessary to determine the nature and extent of *Athos* oil in the samples.

4.1.2.3 Sediment Toxicity Triad

To assess potential injury to sediment-dwelling organisms, DNREC collected whole-sediment samples from the vicinity of Tinicum Island, Claymont/Oldmans Point, and Pea Patch Island (Table 2). Surficial (0-2") sediment grabs were collected with a Ponar IV sampling device and analyzed with a sediment quality triad approach that included measuring PAHs and total organic carbon (TOC) concentrations, evaluating the toxicity of whole sediment samples to the amphipod *Leptocheirus plumulosus* in 10 day toxicity tests, and assessing benthic invertebrate community structure (EA Engineering 2005a, *ibid.* 2005b, *ibid.* 2005c).

The results of the toxicity tests indicate that the samples collected in the vicinity of Tinicum Island were toxic to amphipods on 15 December 2004 and 17 February 2005 (based on control adjusted survival of 39 and 62 percent at Tinicum Island (Figure 8). None of the other sediment samples was found to be toxic to this species. Given background levels of PAHs found throughout the Delaware watershed, determination of the extent to which the measured concentrations of PAHs or the measured toxicity was directly associated with the *Athos* incident would require further assessment.

Table 2. Sediment toxicity sample locations and dates.

| Sample Location | Latitude | Longitude | Sample Date | | |
|------------------------|-------------|-------------|-------------|----------|---------|
| | | | 11/29/04 | 12/15/04 | 2/17/05 |
| Tinicum Island | 39 51.007 N | 75 16.381 W | | X | X |
| Claymont/Oldmans Point | 39 47.816 N | 75 26.873 W | X | X | X |
| Pea Patch Island | 39 35.941 N | 75 34.961 W | X | X | X |

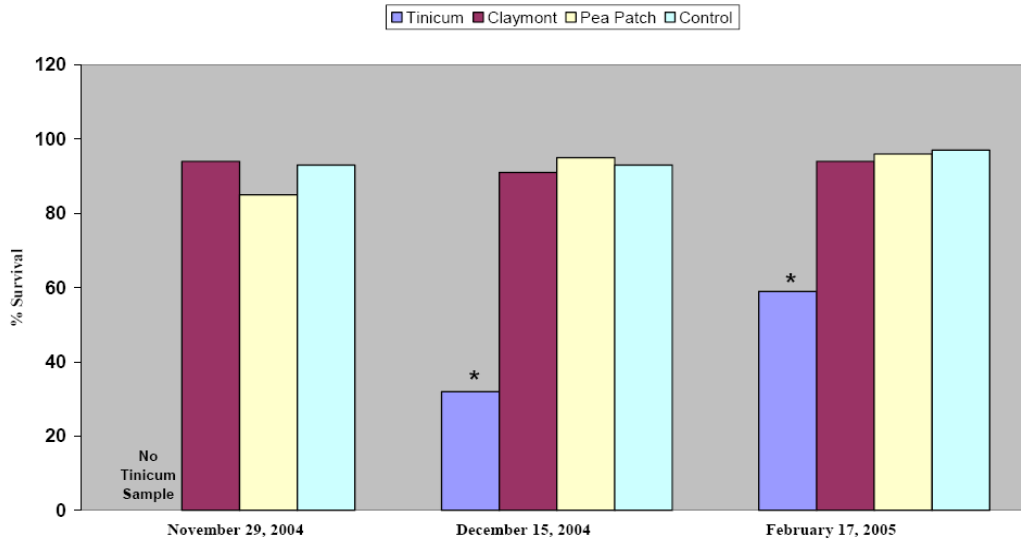


Figure 8. Ten day percent survival of *Leptocheirus plumulosus* (from Rick Greene, Delaware DNREC).

4.1.3 Oysters

Oysters are bioindicators of pollution because they filter seawater and accumulate PAHs in their tissues. The trustees and RPs collected oyster samples to determine potential risks to (1) human health from consumption, (2) oysters based on contaminant body burden, and (3) piscivorous animals that might consume tainted oysters.

Samples were collected for tissue analyses at 12 locations between approximately Liston Point, DE, and Egg Island Point, NJ on 7 and 9 December 2004, and at four locations in the Bay on 24 February 2005 (Delaware Bay False Egg, Delaware Bay Ben Davis, Delaware Bay Arnolds Pt., Delaware Bay Hope Creek) (Figure 9).

At each sample location, approximately 10-12 oysters were dredged from the oyster beds, wrapped in two layers of aluminum foil, and placed in a plastic bag. All samples were stored on ice and sent to GERG under proper chain of custody, where animals were removed from their shells, homogenized, and analyzed for PAHs (modified USEPA Method 8270). Additional analyses included biomarker analyses of the 12 samples collected on 7 and 9 December and trace metal analyses of the samples collected on 9 December 2004.

Sample locations and total PAH concentrations found in the 16 oyster tissue samples are shown on Figure 9. Laboratory data in the tissue samples are found in Appendix F. Oyster tissue PAH ranged from 13.2 to 28.9 ng/g wet weight (ppb). Further analysis of these data are necessary to determine whether *Athos* oil is present in the samples. Oyster tissue PAH levels (specifically benzo[a]pyrene) were below thresholds of concern for human health and bioaccumulation in piscivorous mammals (Sample *et al.* 1996).⁷

⁷ In a conservative risk analysis, the total PAH concentration was compared to the benzo[a]pyrene threshold to compensate for the B[a]P toxicity equivalents from other PAHs.

NOAA's National Status and Trends (NS&T) Program Mussel Watch Project maintains several sampling sites in the Delaware River Estuary. On 2 January 2005, oysters were collected from three sites in the Delaware River Estuary (Hope Creek, Arnolds Point Shoal and Ben Davis Point Shoal) to compare post spill and historical data. A stainless steel oyster dredge was used to collect samples from the three sites and the oyster tissues were analyzed for PAHs. The NS&T PAH concentrations at Hope Creek, Arnolds Point Shoal and Ben Davis Point were 1041 ng/g dry weight (ppb), 951 ng/g dry weight and 459 ng/g dry weight, respectively (Appendix F). Further analyses of these and historical data are needed to assess potential impacts associated with the *Athos* incident.

4.1.4 Fish

Search teams surveying oiled shorelines recovered 25 dead fish, including two bullhead catfish (*Ameiurus nebulosus*), two striped bass (*M. saxatilis*), fifteen white perch (*M. americana*), and one gizzard shad (*Dorosoma cepedianum*), that were oiled to varying degrees (E. Marek, written communication⁸). Necropsies or other cause of death analysis would be required to determine the cause of mortality of these fish and, importantly, when these fish were exposed to oil (e.g., pre- or post- mortality).

The trustees and RPs collected perch, catfish, and gizzard shad from the River for tissue analysis (fillet and whole-body) to determine potential risks to (1) human health from consumption, (2) fish based on contaminant body burden, and (3) piscivorous animals that might consume the tainted fish (e.g., aquatic mammals such as river otters, as well as birds such as ospreys, eagles, belted kingfishers, and great blue herons). Tissue samples were collected on 9 and 16 December 2004. Sampling location were: (1) near the mouth of Mad Horse Creek, NJ, (2) north of the Tacony-Palmyra Bridge, (3) south of Tincum Island, PA, (4) at Marcus Hook, PA, (5) off the mouth of the Christina River, DE, and (6) north of Pea Patch Island, DE (Figure 10).

Fish samples were collected with a tow net. Fish that were large enough for analysis were removed from the net and wrapped in several layers of aluminum foil, then placed in a plastic bag. All samples were stored on ice, sent to GERG under proper chain of custody, and analyzed for PAHs (modified USEPA Method 8270). The catfish were homogenized as whole body samples. The perch and shad were filleted and the skin removed (and included in the remaining carcass).

⁸ Eric W. Marek, Special Agent, USFWS, Office of Law Enforcement, Elizabeth, NJ, by email April 26, 2006.

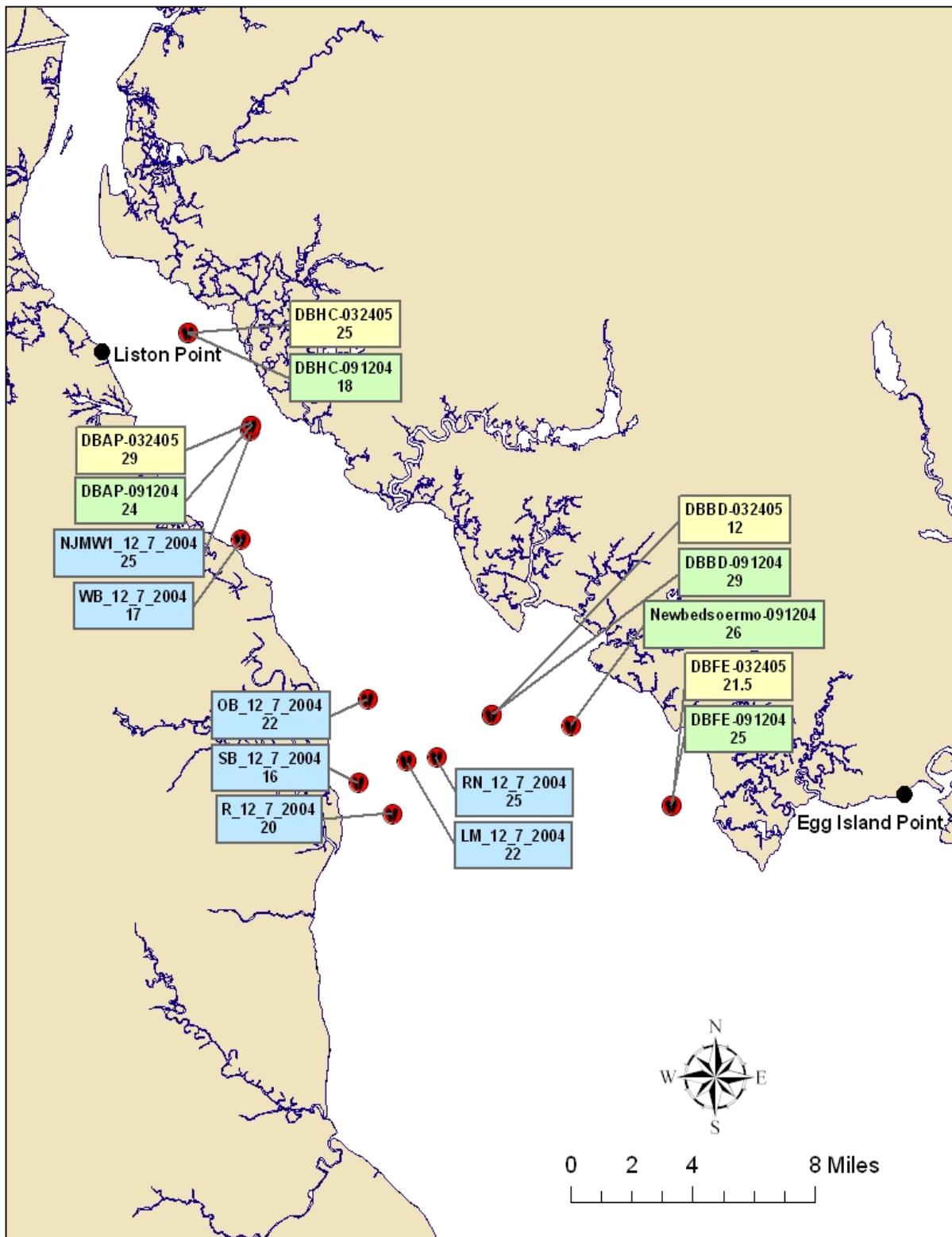


Figure 9. Oyster sample locations and total PAHs (ng/g) in the Delaware Bay. Total PAH values (ng/g) are presented in boxes below sample identification code. Box color represents sample collection date: 7 December 2004 (blue), 9 December 2004 (green), and 24 February 2005 (yellow).

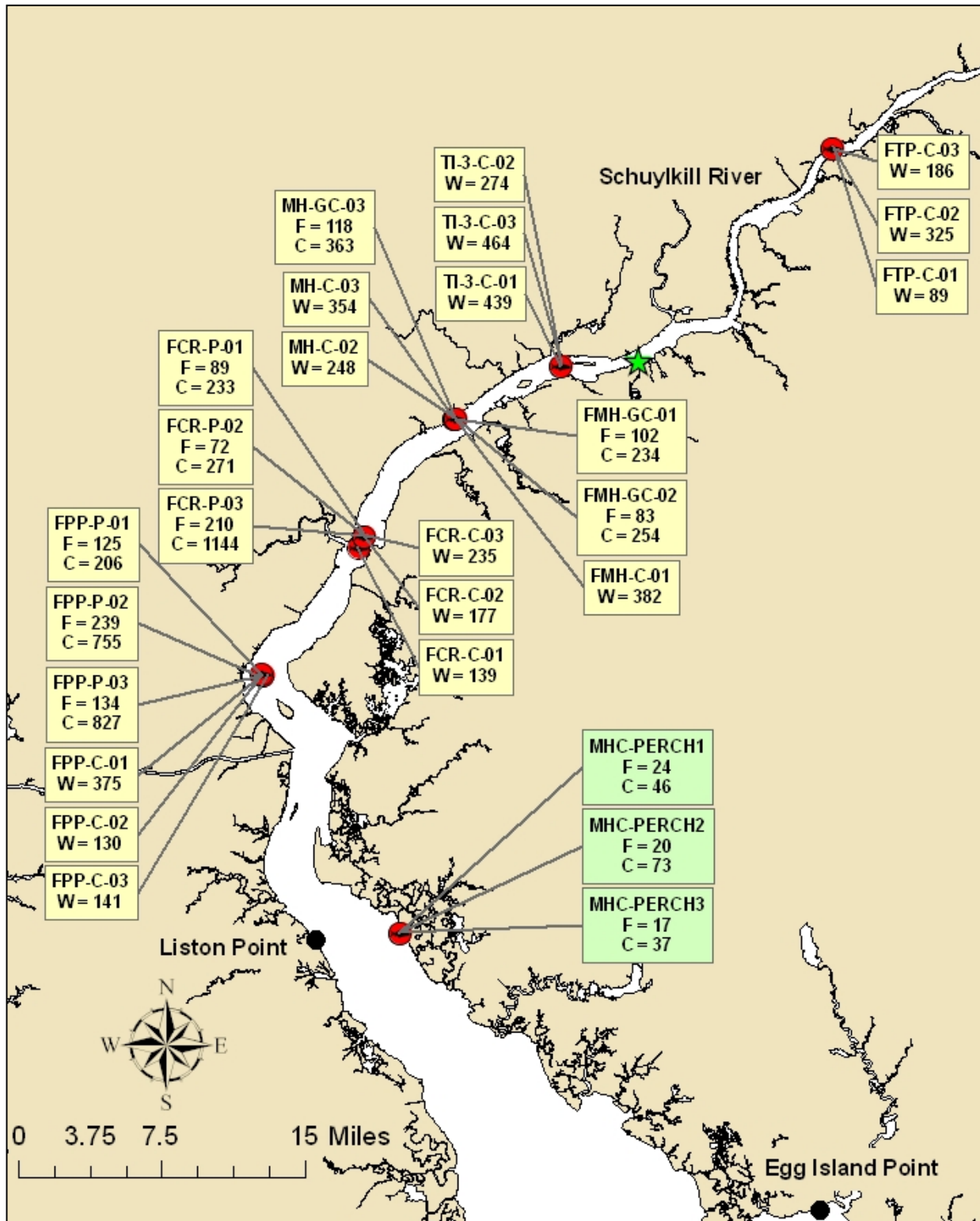


Figure 10. Fish trawl sampling locations and total PAHs (ng/g) in the Delaware River. Box color represents sample collection date: 9 December 2004 (green), 16 December 2004 (yellow). "F" indicates fillet samples; "C" indicates carcass samples. Green star is approximate spill location.

Sample location and total PAH values for the 9 and 16 December 2004 samples are presented in Figure 10. Results of the more detailed PAH analyses are presented in Appendix G. In summary, samples ranged from 88.9 to 464.3 ng/g wet weight (whole body, catfish); 72.1-238.9 ng/g wet weight (fillet, perch and shad); and 205.6 to 1143.6 ng/g wet weight (carcass, perch and shad). Lipid-normalized concentrations of PAHs are below the threshold for PAH-induced narcosis in fish (Di Toro *et al.* 2000). While further analysis of these data is necessary to determine the nature and extent of *Athos* oil in the samples, total PAH concentrations in samples were below a benzo[a]pyrene threshold of concern for bioaccumulation in piscivorous mammals (Sample *et al.* 1996). All data, including individual PAHs, are presented in Appendix G.

The trustees also collected adult striped bass on 3, 10, 11, 27, and 31 May and 5 July 2005 from the Delaware Bay and the Delaware River near Tinicum Island and north of the Schuylkill River. Fifteen fish were collected, with fillets and carcasses subsequently analyzed for total and individual PAHs. The average total PAH concentrations ranged from 9.7 to 130.6 ng/g wet weight for fillets and 11.5 to 291.5 ng/g wet weight for carcasses. Lipid-normalized concentrations of PAHs are below the threshold for PAH-induced narcosis in fish (Di Toro *et al.* 2000). A preliminary evaluation indicates these values for striped bass would not trigger a fish advisory when using EPA guidance numbers (cancer health endpoint). All data are presented in Appendix G.

The trustees also monitored DNREC's juvenile and adult fish trawl surveys. Juvenile surveys were conducted at 39 stations throughout the Delaware Estuary between April and October 2005. Adult surveys were conducted at nine stations between March and December 2005. As of September 2005, 234 juvenile surveys (39 stations x 6 months) and 63 adult surveys (9 stations x 7 months) were made and no oil was observed.

Striped bass young of year surveys conducted by NJDEP were also monitored. As part of an annual effort in the Delaware River since 1980, thirty-two fixed stations are sampled twice a month from June through November. During the 2005 seining surveys, some type of oil was observed at most stations from Raccoon Creek to Eagle Point. During warm and hot days, small (dime-sized or smaller) oil globules were observed in the shallow waters. These globules would dissipate to a sheen and eventually completely dissociate when disturbed (T. Baum, personal communication⁹). Samples were not collected to evaluate the nature and extent of *Athos* oil.

4.1.5 Horseshoe Crabs and Whelks

Twenty-three dredge tows were made in the upper Delaware Bay on 18 March 2005 by DNREC to collect and observe horseshoe crab and knobbed whelks. Sampling was conducted by removing all live horseshoe crabs and whelks from half of the dredge contents. Live horseshoe crabs and whelks in the samples were counted and examined for the presence of oil.

Table 3 summarizes observation from the 23 tows. A total of 136 horseshoe crabs and 477 knobbed whelks were examined. No oil was observed.

⁹ Mr. Tom Baum, NJDEP.

Table 3. Incidence of oiled horseshoe crabs and whelks.

| Location | # tows sampled | # horseshoe crabs examined | # oiled horseshoe crab observed | # whelk examined | # oiled whelk observed |
|--------------|----------------|----------------------------|---------------------------------|------------------|------------------------|
| A | 11 | 70 | 0 | 325 | 0 |
| B | 12 | 66 | 0 | 152 | 0 |
| Total | 23 | 136 | 0 | 477 | 0 |

Horseshoe crab spawning surveys were also conducted by DNREC and NJDEP between May and June 2005. Thirteen beaches in Delaware and 11 beaches in New Jersey were surveyed, covered approximately 130 km and 80 km, respectively, of shoreline. Preliminary indications are that no oil was observed on the beaches or the horseshoe crabs during the surveys.

The United States Geological Survey, in conjunction with DNREC and NJDEP, conducts an annual horseshoe crab tagging survey in the Delaware Bay between March and May. In 2005, horseshoe crabs collected from these surveys were monitored for the presence/absence of oil on the exoskeleton. No oil was detected on the approximately 8,700 horseshoe crabs that were observed during these surveys.

4.2 Shorelines

Fresh to saltwater wetland areas, wild rice marshes, sand beaches, mud flats, and tidal creeks are among the environmentally important shorelines affected by the spill. A variety of shoreline habitats were exposed to oil, including seawalls, marshes, and sand and mud habitats. Potential injuries include toxicity of the oil and smothering, which both may result in a loss of habitat and production.

4.2.1 Shoreline Cleanup Assessment

The shorelines within and adjacent to the spill zone were surveyed by Shoreline Cleanup Assessment Teams (SCAT) on a near continuous basis from 29 November 2004 to 13 February 2005. Standard SCAT procedures were used to document the extent and magnitude of oiling (NOAA, 2000), including length and width of oiling, percent of oil coverage, oil character, and thickness, as well as habitat conditions including length and width of shoreline, habitat type, substrata type, and wave exposure.

SCAT surveys were conducted over approximately 550 miles of shoreline along the mainstem of the Delaware River. For each designated segments, the nature, extent and severity of shoreline oiling was assessed as either Heavy, Moderate, Light, Very Light, or No Oiling based on the shoreline oiling width and thickness (Appendix H).

Table 4 presents the length of shoreline oiling by shoreline type and degree of oiling. Figure 11 graphically depicts shoreline oiling as of 10 May 2005. Of the approximately 550 miles

surveyed, almost 280 miles of shoreline were oiled to varying degrees.¹⁰ Substantial shoreline oiling also occurred within the tributaries. Predominant shoreline types exposed to oil include seawalls, sand beaches, coarse substrate, mud flats, and marshes (Figure 11).

Table 4. Approximate length in miles of shoreline habitat by oiling degree. These numbers do not include the length of oiled shoreline in tributary creeks. See Appendix H for definition of oiling categories.

| Habitat | Very Light | Light | Moderate | Heavy | Total |
|--------------------|------------|-------|----------|-------|-------|
| Seawalls | 13 | 24 | 37 | 4 | 78 |
| Sand/Mud Substrate | 18 | 11 | 10 | 6 | 44 |
| Coarse Substrate | 37 | 18 | 9 | 5 | 69 |
| Marsh | 70 | 20 | 4 | 2 | 96 |
| Total | 138 | 73 | 60 | 17 | 287 |

In addition to the SCAT surveys, the PA Bureau of Forestry contacted Dr. Ann Rhoads at the Morris Arboretum of the University of Pennsylvania to request that she survey the plants around Tinicum Island. Dr. Rhoads reported that plants visible on the tidal flats included dormant leaves of spatterdock (*Acorus calamus*), arrowhead (*Sagittaria rigida*), arrow-arum (*Peltandra virginica*), and dwarf spike-rush (*Eleocharis parvula*). Black oil was noted on the leaves of many, but not all, of these plants. The full report prepared by Dr. Rhoads is included in Appendix H.

¹⁰ The length in Table 4 (287 miles) is greater than the total length of oiled shoreline because some segments have two habitat types present.

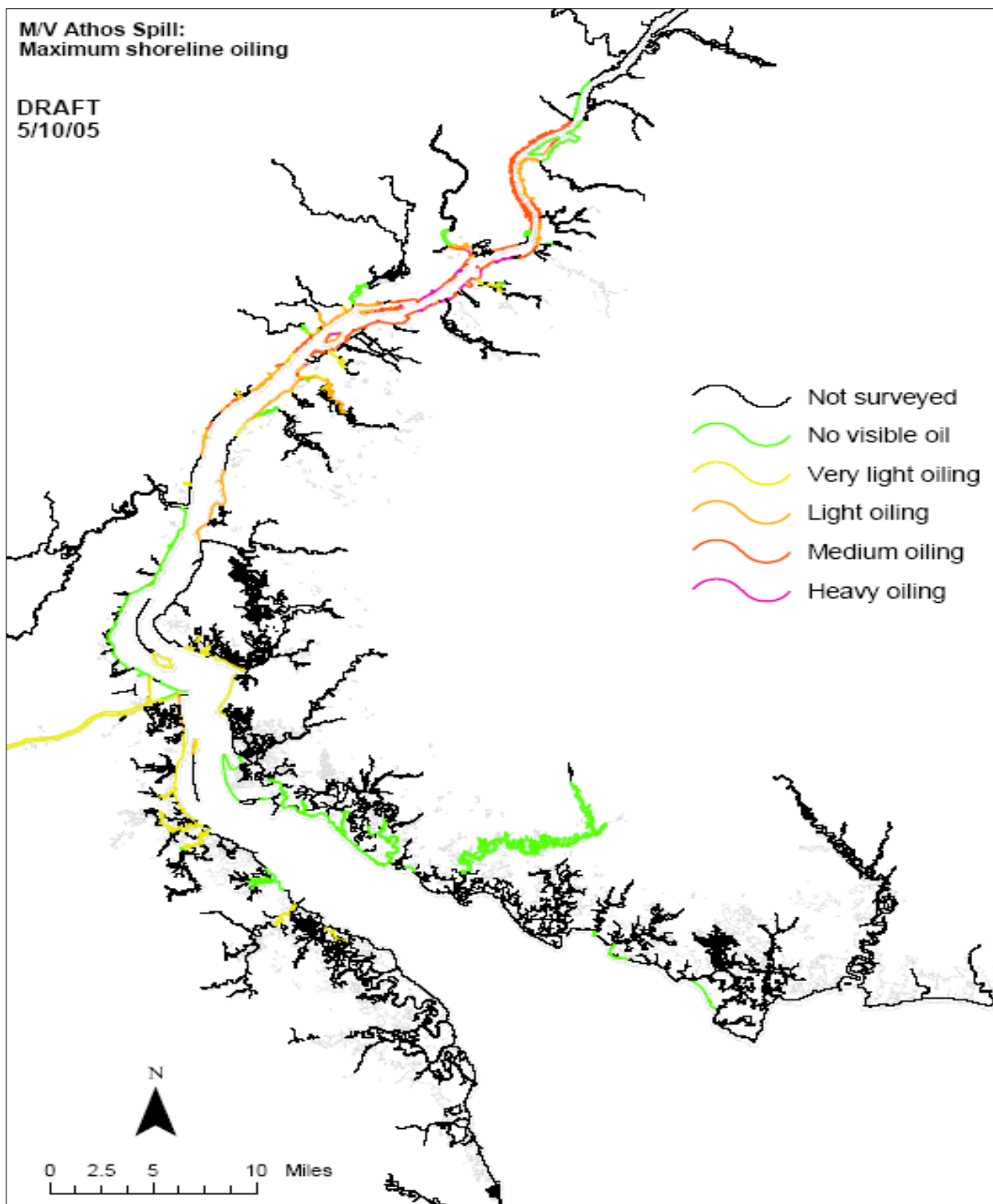


Figure 11. Maximum shoreline oiling, as reported in May 2005.



a. Oiled seawall



b. Oiled sand beach.



c. Oiled coarse substrate beach



d. Oiled intertidal mud flat



e. Oiled marsh.

Figure 12a-e. Representative examples of shoreline oiling observation; (a) seawalls, (b) oiled sand beach, (c) oiled coarse substrate beach, (d) oiled intertidal mud flat, and (e) oiled marsh.

4.3 Birds and Wildlife

Bird and wildlife resources at risk include migrating marsh birds, egret and heron rookeries, eagles and osprey, and migratory shorebirds. The federally-threatened piping plover (*Charadrius melodus*) inhabits the Lower Delaware Bay. There are also a variety of mink, otter, turtles, and terrestrial fauna that use the affected area. Major pathways of exposure are ingestion and fouling of fur and feathers.

4.3.1 Wildlife Response and Rescue Operations

Immediately following the spill, search teams began patrolling oiled shoreline areas and coordinating observations of dead and oiled wildlife with response/ cleanup crews, bird ground survey crews, and Tri-State Bird Research and Rescue in Delaware. Wildlife rehabilitation occurred at the Frink Center for Wildlife in Newark, DE and the John Heinz Wildlife Refuge in Philadelphia, PA. By May 2005, a number of oiled birds were observed (Figure 13); 206 wild birds were collected dead, died at the rehabilitation center, or were unable to be released to the wild, and 337 birds were rehabilitated and released alive (E. Marek, written communication¹¹) (Table 5). Recovered wildlife that were collected dead or died at the rehabilitation center included three turtles, one squirrel, one opossum, one red fox, and one woodchuck (E. Marek, written communication¹²). Two turtles were unable to be released to the wild and were placed domestically.



Figure 13. Observed oiled birds.

4.3.2 Wildlife Ground Surveys

The trustee and RP representatives conducted ground surveys to estimate the extent and degree of oiling of non-recovered wildlife. More than 3,400 surveys were conducted between 30 November 2004 and 10 January 2005 (Appendix I), typically at fixed points accessible via foot, vehicle, or boat. Site locations were selected based upon review of oil distribution maps and trajectory models produced as part of the response, as well as aerial survey results described below. Between one and three observers were present at each site visit. All visible birds in open water, adjacent wetlands, spoil banks, and adjacent upland habitats were counted. Additional observations included date, time, duration on site, behavior, and oiling descriptor (trace, <6 percent body surface oiled; light, 6-20 percent body surface oiled; moderate, 21-40 percent body surface oiled, or heavy, >40 percent body surface oiled).

Data on the total number of birds observed by species, most observed in one day, most observed oiled in one day, and degree of observed oiling are provided in Appendix I. Nearly 157,500

¹¹ Eric W. Marek, Special Agent, USFWS, Office of Law Enforcement, Elizabeth, NJ, by email April 26, 2006.

¹² Eric W. Marek, Special Agent, USFWS, Office of Law Enforcement, Elizabeth, NJ, by email April 26, 2006.

birds were counted, with about 16,500 (10 percent) having some degree of oiling. About 72 percent of all oiled birds observed had trace or light oiling; 19 percent of oiled birds were moderately oiled; and nine percent of oiled birds were heavily oiled.

The most common species observed are reported in Table 6. Nearly half of all oiled birds observed were geese. Canada geese, mallards, and gulls made up 91 percent of observed oiled birds. These species also composed the majority of all birds observed (Appendix I).

Table 5. Summary of data on recovered birds from the rehabilitation center.

| Species | Rehabilitated/Released | Dead |
|---|------------------------|------------|
| American black duck | 2 | 1 |
| Blue-winged teal | - | 1 |
| Duck sp. | 0 | 2 |
| Mallard | 11 | 25 |
| American coot | - | 1 |
| Bufflehead | 3 | 1 |
| Canvasback | - | 1 |
| Long-tailed duck | - | 1 |
| Ruddy duck | - | 1 |
| Black Scoter | - | 1 |
| Double-crested cormorant | - | 9 |
| Northern gannet | - | 1 |
| Great black-backed gull | - | 2 |
| Gull sp. | - | 22 |
| Herring gull | 7 | 26 |
| Ring-billed gull | 25 | 17 |
| Belted kingfisher | - | 3 |
| Canada goose | 287 | 80 |
| Mute swan | - | 1 |
| Snow goose | 2 | 6 |
| Great blue heron | - | 2 |
| Unidentified | 0 | 2 |
| Total Wild | 337 | 206 |
| Domestic geese ² | 32 | 1 |
| Domestic ducks ² | 4 | 0 |
| Total Domestic | 36 | 1 |
| <p>1. This number includes birds that survived at the rescue center, but were unable to be rehabilitated sufficiently for successful release to their natural habitat. Eleven mallards and six Canada geese were placed in domestic situations.</p> <p>2. For domestic birds, successful rehabilitation resulted in return to a domestic situation.</p> | | |

Table 6. Most common birds observed oiled during ground surveys. Data analysis as of May 2005.

| Species name | Total Oiled Bird Observations | Percent of all Oiled Birds |
|--|-------------------------------|----------------------------|
| Canada Goose | 8041 | 49 |
| Great black-backed gull | 469 | 3 |
| Herring Gull | 915 | 6 |
| Mallard | 447 | 3 |
| Ring-billed Gull | 5422 | 33 |
| Total | | 91 |
| Note: Percentages do not sum to total due to rounding. | | |

4.3.3 Aerial Bird Surveys

The trustee and RP representatives conducted 11 aerial surveys between 28 November 2004 and 28 December 2004 to assess the species composition and abundance of birds in the spill area. In New Jersey and Pennsylvania, aerial surveys covered main-stem shorelines and all tributaries upstream to the point where overhanging tree canopies obscured visibility of birds below. Aerial surveys in Delaware covered approximately 50 percent of the Bay's shoreline below the Delaware Memorial Bridge and much smaller portions of tributaries and adjacent marsh complexes. In these estuarine marsh complexes, birds were counted to 250 meters on each side of the aircraft, but at least 50 meters of each side of the aircraft is obscured below the aircraft. Aerial surveys were conducted using Bell 206 helicopters or Cessna 206 fixed-wing aircraft. Bird surveys were performed with one or two observers. All visible birds in open water, adjacent wetlands, spoil banks, and adjacent upland habitats (*e.g.*, farm fields, parks, and corporate lawns) were counted. Observations were recorded on a hand-held tape recorder and transcribed after the flight. Most helicopter surveys were performed at altitudes of 30-120 meters and airspeeds of 40 knots, depending on flight conditions, proximity of obstructions, and other factors. Fixed-wing aircraft surveys were typically flown at higher altitudes and airspeeds. The route of the aircraft on any given survey was adjusted for the number of observers, wind speed and direction, sun angle and tide level.

Birds were identified to the highest taxonomic level (typically species) possible. Some species were difficult to differentiate from the air (*e.g.*, greater and lesser scaup; ring-billed, herring, and greater black-backed gulls; and shorebirds). The aerial surveys were best able to detect species that are large, brightly colored, abundant, and widely distributed in area. As an example, observers were more likely to see tundra swans (large and bright) and Canada geese (large) than green-winged teal (small) or shorebirds (very small). Less abundant birds mixed with flocks of more abundant birds are also often missed in surveys.

The number of birds observed during each of the 11 aerial surveys, along with the general location of the flight is presented in Table 7 and Appendix I. Total observed birds ranged from about 2,600 on 3 December 2004 to nearly 100,000 on 5 December 2004. While these counts do not reflect a standard flight time or area covered, in general, more birds moved into the area as it became colder and later in December 2004. Observation conditions were excellent on 2 December, fair on 5 and 7 December and poor on 15 December due to high winds. Available

daylight and time were a factor on all days in that several marshes along the central NJ coast were not flown in order to get to Alloway Creek and Salem River, where most of the oil was located, before dark. On 15 December, much of the Delaware marshes were frozen in the morning resulting in lower numbers of birds observed in the marshes. Tides and winds affect the number of birds in the shores of the Bay where most of the black ducks and mallards are observed. On 2 December, high tides and winds blowing from the west resulted in New Jersey marshes being flooded and many black ducks and mallards being concentrated on the coast.

Table 7. Aerial Bird Survey Summary for Delaware River segments. Counts by species are presented in Appendix I.

| Date | Number of Birds observed | Predominant Species Observed | Area surveyed |
|-------------|---------------------------------|--|---------------------------------|
| 28-Nov | 3,392 | Black ducks, mallards, buffleheads, gulls, Canada geese | Portion of north NJ shoreline |
| 29-Nov | 7,555 | Black ducks, gulls, Canada geese | Portion of north NJ shoreline |
| 30-Nov | 5,030 | Black ducks, mallards, ruddy ducks, buffleheads, gulls, Canada geese | NJ and PA shorelines |
| 2-Dec | 59,123 | Black ducks, green-winged teal, mallards, ruddy ducks, buffleheads, gulls, Canada geese, snow geese | DE and NY shorelines |
| 3-Dec | 2,577 | Mallards, gulls, Canada geese | PA shoreline |
| 5-Dec | 98,245 | Black ducks, gadwall, green-winged teal, mallards, pintails, buffleheads, ruddy ducks, scaup, gulls, gannet, Canada geese, snow geese, swans | NJ, PA, and DE shorelines |
| 9-Dec | 12,716 | Black ducks, green-winged teal, mallards, pintails, ruddy ducks, gulls, Canada geese | Portions of NJ and PA shoreline |
| 13-Dec | 17,825 | Black ducks, green-winged teal, mallards, pintails, gulls, Canada geese | North NJ and PA shoreline |
| 15-Dec | 70,209 | Black ducks, green-winged teal, mallards, gulls, Canada geese, swans, snow geese | DE and south NJ shorelines |
| 16-Dec | 51,096 | Black ducks, green-winged teal, mallards, pintails, gulls, Canada geese, greater white-fronted geese | DE and south NJ shorelines |
| 21-Dec | 19,516 | Black ducks, mallards, pintails, canvasback, merganser, gulls, Canada geese | North NJ and PA shorelines |

4.4 Lost recreational use

Many types of recreation are popular along the Delaware River in the areas affected by the incident. The River and its tributaries support numerous marshes that are popular for waterfowl hunting. Boating, fishing, crabbing, as well as beach and other shoreline use, are also popular recreational activities throughout the region.

Following the spill, hunting and boating advisories were issued in Delaware and New Jersey, closing certain areas. In Delaware, state lands were closed to hunting as far south as Cedar Swamp Wildlife Area. In New Jersey, the hunting advisory included most areas within five miles of the River from the Tacony-Palmyra Bridge to the nuclear power facility in Salem, NJ. The advisories were in effect for about two weeks.

As part of the preassessment efforts, the trustees collected data to begin determining the potential for loss of the human uses, including hunting, boating, fishing, crabbing, and beach and other shoreline use. Shoreline use (*e.g.*, fishing, boating, walking) was documented during several overflights. Interviews with marina owners were also conducted to determine the potential impacts to recreational boating.

In general, the level of recreational boating at the time of the incident appeared low, although some boat-based fishing typically continues throughout the year. Sporadic problems with oil were also reported at marinas in the area.

Additional information necessary to quantify the injury for each of the recreational resource use categories will be collected as needed.

5.0 REFERENCES

- Di Toro, D.M., J.A. McGrath, D.J. Hansen. 2000. Technical Basis for Narcotic Chemicals and Polycyclic Aromatic Hydrocarbon Criteria. I. Water and Tissue. *Environmental Toxicology and Chemistry*. Vol. 19, No. 8, pp. 1951-1970.
- EA Engineering, Science, and Technology, Inc. 2005a. Results of Toxicity Testing with *Leptocheirus pumulosus* on Sediment Samples from the Delaware River (EA Report Number 4677, dated 27 January 2005). Report prepared for the Delaware Department of Natural Resources and Environmental Control, Division of Air and Waste Management, New Castle, DE.
- EA Engineering, Science, and Technology, Inc. 2005b. Results of Toxicity Testing with *Leptocheirus pumulosus* on 17 February 2005 Sediment Samples from the Delaware River (EA Report Number 4750, dated 26 April 2005). Report prepared for the Delaware Department of Natural Resources and Environmental Control, Division of Air and Waste Management, New Castle, DE.
- EA Engineering, Science, and Technology, Inc. 2005c. Results of Toxicity Testing with *Leptocheirus pumulosus* on 15 December 2005 Sediment Samples from the Delaware River (EA Report Number 4691, dated 4 March 2005). Report prepared for the Delaware Department of Natural Resources and Environmental Control, Division of Air and Waste Management, New Castle, DE.
- Meyers, R.A. (editor) 2004. Handbook of petroleum refining processes. Third edition. McGraw-Hill. New York, NY.
- National Oceanic and Atmospheric Administration, 2000. Coastal resources atlas: Delaware, New Jersey, and Pennsylvania. National Ocean Service, Office of Response and Restoration.
- Neff, J.M., S.A. Strout, and D.G. Gunster. 2005. Ecological risk assessment of polycyclic aromatic hydrocarbons in sediments: Identifying sources and ecological hazards. *Integrated Environmental Assessment and Management* 1(1): 22-33
- Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. Toxicological benchmarks for wildlife: 1996 Revision. ES/ER/TM-86/R3. Office of Environmental Management. United States Department of Energy. Oak Ridge, Tennessee.
- U.S. Coast Guard, 2005. T/S ATHOS I Evaluation Report. USCG National Strike Force Coordination Center, Elizabeth City, NC, August 2005.
- U.S. Coast Guard, 2006. Investigation into the striking of submerged objects by the tank vessel ATHOS I in the Delaware River on 26 November 2004 with a major discharge of oil, January 2006.