# EMERGENCY MARSH RESTORATION AS PART OF RESPONSE TO THE SWANSON CREEK (MARYLAND) OIL SPILL

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**ABSTRACT:** *This oil spill on 7 April 2000 offers a case example where marsh restoration was made as part of the* response *effort to successfully enhance environmental recovery at a marsh heavily contaminated from a pipeline break (126,000–139,000 gallons of Numbers 2 and 6 fuel oils, >46,000 gallons eventually recovered). Marsh operations guided by U.S. EPA included mechanical trenching, limited low-to-moderate pressure flushing, hand recovery using sorbent pads and working from placed boardwalks, and the aerial application of fertilizer (bio-stimulation). After proving that planting would be successful in pilot plots and in a heavily damaged portion of the marsh, almost all of 'ground zero' (W01A) was hand-planted between 21 June and 31 July 2000 with 24,048 plugs of* Spartina alterniflora *and 1,728 plugs of* S. patens *(saltmeadow cordgrass). Both species were locally grown, nursery stock from native seed. Plants were placed in a 3" (8 cm) diameter hole containing 10 grams of slow release fertilizer and back-filled with washed masonry sand. Field surveys indicate recovery of 70-80% after one year and near complete recovery two years after. In spite of no apparent credit being given for replanting by government-lead Damage Assessment studies (NOAA et al., 2002), results clearly indicate that proactive planting during the response results in an environmental benefit and reduces the time needed for marsh recovery after an incident.*

## Introduction

This report describes the response effort undertaken in marshes along Swanson Creek, with particular emphasis on replanting activities conducted in the most heavily oiled marsh (W01A) following a pipeline break along its western fringe on 7 April 2000. Planting was conducted as part of the response effort in order to minimize and repair damage to the marsh caused by oiling and cleanup activities, stabilize the substrate, minimize colonization by undesirable plant species, and aid in the rapid colonization of desirable wetland plant species. Additionally, because these replanting response actions (assumedly beneficial) affect the long-term damages to the area as determined under the U.S. Damage Assessment and Restoration Program (DARP), the influence of replanting on DARP's final determination is also reviewed.

The history of the incident is summed up as follows. The spill occurred on 7 April 2000 and was caused by a leak in the 12-inch underground pipeline connecting to the Pepco (Potomac Electric Power Company) Chalk Point generating facility at Aquasco, Maryland. It occurred on the property of the generating plant on the northern shoreline of Swanson Creek, approximately 0.5 mile (0.8 km) from the Patuxent River. Waters are of low salinity, show only minor tidal variation (2 ft, 60 cm or less), and are highly influenced by river discharge levels.

In total, the loss encompassed 126,000 to 139,000 gallons of mostly Number (No.) 2 fuel oil, which was being used to back-flush the pipeline system at the time of the break, mixed with a lesser amount of No. 6 fuel oil that remained in the pipe after transport to the facility and that was mixed into the No. 2 oil via previous back-flush operations. Booms were rapidly deployed in Swanson Creek adjacent to the break and recovery was initiated. Unfortunately, severe winds occurred on the following night (8 April) where upon oil then got past the booms and into the Patuxent River, eventually spreading 17 miles (27 km) downstream and oiling approximately 40 miles (64 km) of shoreline. Of all areas, the marshes in Swanson Creek received the brunt of impacts, especially the marsh designated as W01A, located immediately adjacent to the leak. A location map and an oblique aerial photograph of the Swanson Creek marshes are presented in Figures 1 and 2.

State and federal government agencies determined that a series of highly invasive cleanup operations would be undertaken in Marsh W01A and W01B. W01C would remain untouched to be used as a control, and W01D had no access at the time, so activities in this area were postponed (and never taken).

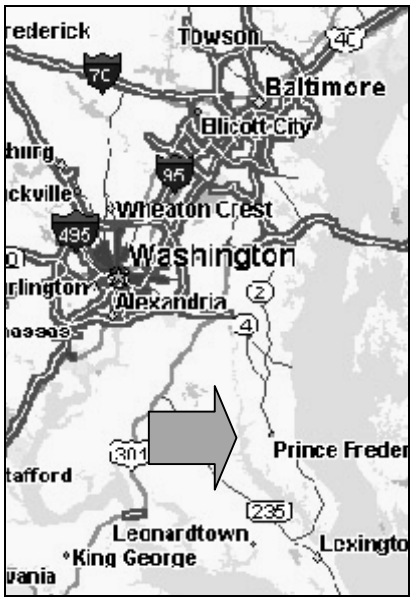



Figure 1. Location of spill site with respect to Washington, DC, and Baltimore, Maryland.

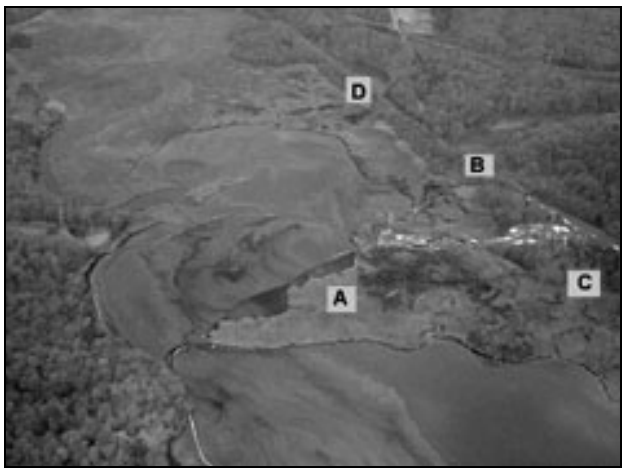



Figure 2. Oiling condition on 15 April 2000, and marsh designations W01A to W01D.

Authors Gundlach and Barry arrived on-scene on 17 April as part of the Pepco-sponsored Gallagher Marine Spill Management Team. In the interim, between 7 April and 17 April, the following activities had taken place in the marsh:

- The Environmental Protection Agency (EPA) appointed an EPA member to remain on-site in the marsh area and oversee its cleanup.
- Shore-seal boom was placed around the entire area of W01A to prevent further transport of the oil out of the marsh (setting up W01A as a sacrificial marsh). As this boom forms a seal with the bottom, very little oil was able to flush out of the marsh. Outside of this, several lines of harbor boom and sorbent boom had been placed in Swanson Creek to retain and absorb floating oil. The shore-seal boom remained in place for several weeks until removal (to aid marsh flushing) at the insistence of the Pepco/Gallagher Marine Operations Section Chief.
- A series of boardwalks composed of wood planking, each having a length of 10 to 12 feet (3.3 to 3.7 m) and weighing 80 to 100 pounds (35-45 kg) had been placed across the marsh surface in areas W01A, W01B, and W01C to facilitate access by workers. Four workers were commonly needed to move each boardwalk section. To avoid boardwalk flotation and dislocation during high tides, each section was later staked into position.
- A series of trenches had been mechanically dug in W01A to a depth of approximately 2 feet (60 cm), with the objective of enabling oil to flow towards a recovery point at the western edge of the marsh. (This was notably ineffective since topography dictated that flow was in the opposite direction.) No connecting channels were dug to open water, thus further trapping oil in the marsh.
- A moderate-volume flushing system was created in one area encompassing less than 5 percent of the marsh's surface to aid the flow of oil off the surface. Small pumps located along the trenches assisted movement of the oil to enable capture.
- Over 125 cleanup workers were mobilized to complete the above-listed activities, and to undertake oil recovery primarily using sorbent pads. By 17 April or before, oil was too thin and widely dispersed for vacuum pumping to be effective.
- Some skimming operations were conducted in adjacent Swanson Creek.
- Approval of the Regional Response Team (RRT) had been obtained for the addition of fertilizer to stimulate oil degradation with the proviso for weekly chemical monitoring. EPA would oversee fertilizer application and provide for chemical sampling and analysis.

## Replanting activities

The sequence of events needed to undertake replanting at the W01A marsh is discussed below, after which planting methods are described.

**Phase 1: Replanting fringe vegetation.** Repairs to property damaged by cleanup operations, particularly related to yard repair, were initiated in late April / early May. As part of this effort, several homeowners wished that the marsh strip damaged along their property (which in several cases was being cut as a lawn) would be repaired. After review by representatives of the Responsible Party, EPA, and the State of Maryland, marsh replanting in all but one damaged area was initiated on 1 May and completed a few days later. (The remaining marsh strip was planted several weeks later when permission of the adjacent homeowner was obtained.) This replanting program showed almost immediate success as plants rapidly grew in each site (Figure 3).

**Phase 2: Marsh strategy development and test plots.** Using the fringe replanting as a basis, the Spill Management Team initiated a series of documents to undertake replanting of the damaged Swanson Creek marshes, beginning first with the lesser-oiled W01B marsh. In this case, there was severe reluctance to proceed with replanting in the Swanson Creek marshes. In response to EPA's request for additional information, National Oceanic and Atmospheric Administration (NOAA) provided a letter from its contractor which explicitly

stated that planting would not be successful during the summer months and that replanting was not recommended. This letter, if taken at face value, would have killed any prospect of planting until the following autumn at best, and more likely until the next spring, a full year after the event. As a result, the local planter (who had previously replanted the damaged coastal fringe areas) was again consulted, and we found that summertime was actually his best months for planting, and that successful planting had been undertaken during all seasons. The issue of being able to plant was therefore resolved.

On 12 May, a Marsh Strategy document was signed off by all parties (government agencies and the Responsible Party) which, among other activities, included the following:

- Continued fertilizer bio-stimulation and monitoring, if proved effective. At the end of the bio-stimulation estimated at 3 to 6 weeks, the width and number of walkways would be reduced. Application of fertilizer by hand began on about 11 May, to be replaced later by helicopter application. (It was later found that chemical data were not provided in a timely fashion by the EPA-designated laboratory, and that bio-stimulation effectiveness 'did not have to be proven, because it was shown to be effective elsewhere'. Bio-stimulation and monitoring were continued until September 2000.)
- Installation of test plots in areas where gross oil contamination had been removed.
- Removal of unnecessary wooden walkways. (For example, 105 unneeded boardwalks were removed from W01B in June).

In accordance with the Marsh Strategy document, five 'test' plots were planted with *Spartina alterniflora* on 13-14 May. Site locations contained degrees of oil contamination visually varying from light to heavy. The survival and condition of the plants were then followed over time (summarized in Table 1). Figure 4 shows one replanted site in heavily oiled sediments within W01A. The main conclusion drawn from this study was that *S. alterniflora* will survive the stress of planting in oil, and even some re-oiling, as long as they are not repeatedly coated with oil. In addition to the test plantings, a study was conducted to assess natural re-vegetation. Results indicated that the natural recovery of *S. alterniflora* would be limited during the 2000 growing season.

**Phase 3: Planting the southeast lobe of W01A.** Based on the positive results of the pilot study, planting was considered for other parts of the marsh, but again there was reluctance by several agencies to give approval. Therefore, a larger pilot area was agreed upon. Based on the sequence of cleanup activities and filling in of the trenches, the southeast portion (lobe) of the marsh was selected. Our survey found that the area's substrate was comprised of 80% bare hard (not fluff) mud, 10% coverage by *Spartina alterniflora*, 5% coverage by trenches, and 5% by spoil. Surface oiling showed low surface coverage (<15%) except for a corner pocket (NW) which received additional work. Soil con-tamination was generally low with few to no black oil droplets observed in most areas. Replanting of this area was among the most difficult of all sites because of very soft sediments, several trenches needed infilling, and previously the area may have had relatively sparse vegetative coverage to begin with.


Figure 3. Successfully replanted (*Spartina alterniflora)* coastal strip damaged by cleanup activities. Left - as planting was initiated on 2 May 2000. Right – 5 weeks later on 8 June 2000.

**Table 1. Pilot study data from initial planting followed for 1 month.**

| Plot | Date Planted | Number Planted | % Oil | Survival 20 May | Survival 31 May | Survival 12 June |
|---|---|---|---|---|---|---|
| X | 13 May | 5 | Light | 100% | 100% | 100% |
| Y | 13 May | 8 | Moderate | 100% | 100% | 100% |
| Z | 13 May | 12 | Heavy | 100% | 100% | 100% |
| W | 14 May | 12 | Moderate | 100% | 100% | 100% |
| T | 14 May | 13 | Heavy | 100% | 77% | 54% |

Figure 4. 'Test' plantings in an oiled area of W01A.

All operations in the marsh have the potential for continuing damage, or as a minimum, are likely to inhibit marsh recovery. Therefore, replanting had to be closely coordinated with (1) completion of all oil recovery activities (essentially workers using sorbent pads), (2) infilling and stabilization of the trenches, (3) damage assessment drilling and monitoring activities, and then (4) final removal of all boardwalks and any other obvious signs of our presence in the marsh.

All activities associated with response operations conformed to the work completion schedule except for damage assessment operations and monitoring which could not be 'hastened' to conform to our departure from the marsh. Many boardwalks continue to remain in place (at least for two years, as of this writing) to reach monitoring stations. Boardwalks generally prevent vegetation from growing underneath and may cause damage during changing water levels.

Prior to planting, trenches dug during the first week of the spill had to be filled in to restore the marsh to its original topography. To do so, oil mixed into bottom sediments was removed by using a submerged low-pressure bubbling system (air forced through a slotted PVC-pipe). Trenches were then in-filled with the spoil material placed along the banks during the original excavation. Unfortunately, the spoil material was not of sufficient quantity to fill up the trench, and additionally had no internal cohesiveness (i.e., liquid mud), so fill was augmented with clean river sand. Sand was transported across the marsh boardwalks (double width) on 'Gator' flatbed garden tractors.

Planting of the Southeast Lobe was approved on 19 June by EPA, Maryland Department of the Environment (MDE), and the Responsible Party, with the concurrence of the natural resource agencies (National Oceanic and Atmospheric Association (NOAA), US Fish and Wildlife Service (FWS), and Maryland Department of Natural Resources (MDNR)).

**Phase 4: Completing planting the remaining marsh.** Planting of the Southeast Lobe area was completed with obvious success (plant survival and growth), so approval for the entire W01A oiled marsh was given as part of the Response Action Plan (RAP) on 18 July 2000. All planting activities ended on 31 July. Only minor marsh cleanup activities (e.g., sorbent boom removal) were carried out past this date. In late August and into September, the area around the pipeline was excavated. Contaminated sediment was replaced with clean sand and the area was replanted.

## Planting methods and work summary

For planning purposes, Marsh W01A was divided into seven zones and characterized as to the degree and characteristics of remaining oil, cleanup activities still required, percent coverage of natural vegetation, and suitability of the bare substrate for planting. Planting was undertaken when a zone was determined to have 1) no gross oil contamination, 2) low potential for natural re-vegetation, and 3) a suitable substrate for planting. Substrate type varied throughout the site and was a major factor in determining placement of plants. Planting was always performed during low tide in areas drained of standing water. The presence of standing water disallowed the placement of plants in drainage runnels or in exceedingly soft (water soaked) sediments. Plants were also not placed in areas of naturally occurring re-vegetation.

In total, W01A was planted with 24,048 1-2 inch (3-5 cm) plugs of *Spartina alterniflora* and 1,728 2-inch (3 cm) plugs of *S. patens* (saltmeadow cordgrass). Both species were locally grown, nursery stock from native seed acquired from Water's Edge Nursery, Co. of Easton, Maryland. The number of plants installed per week is summarized in Table 2. Plants were placed in a 3 inch (8 cm) diameter hole containing 10 grams of OsmoCote® and back-filled with washed masonry sand. The OsmoCote® was an 18-6-12 coated fertilizer designed to provide 16% slow-release nitrogen (N), 5% slow-release phosphate ($P_2O_5$), and 11% slow-release soluble potash ($K_2O$) over a 6-9 month period, depending on temperature. Figure 5 shows aerial photographs before and shortly after replanting / trench infilling.

**Table 2. Dates and number of plants installed per date by species.**

| Date | # Planted S. altern. | Total Cum | Date | # Planted S. altern. | Total Cum | Date | # Planted S. altern. | # Planted S. patens | Total Cum |
|---|---|---|---|---|---|---|---|---|---|
| 21-Jun | 504 | 504 | 15-Jul | 288 | 5328 | 26-Jul | 1512 | | 15192 |
| 22-Jun | 350 | 854 | 18-Jul | 792 | 6120 | 27-Jul | 3096 | | 18288 |
| 23-Jun | 480 | 1334 | 20-Jul | 504 | 6624 | 28-Jul | 2160 | 1512 | 21960 |
| 27-Jun | 674 | 2008 | 21-Jul | 1008 | 7632 | 29-Jul | 936 | 216 | 23112 |
| 8-Jul | 1384 | 3392 | 22-Jul | 828 | 8460 | 30-Jul | 2016 | | 25128 |
| 9-Jul | 858 | 4250 | 23-Jul | 828 | 9288 | 31-Jul | 648 | | 25776 |
| 10-Jul | 376 | 4626 | 24-Jul | 864 | 10152 | | | | |
| 11-Jul | 414 | 5040 | 25-Jul | 3528 | 13680 | | | | |

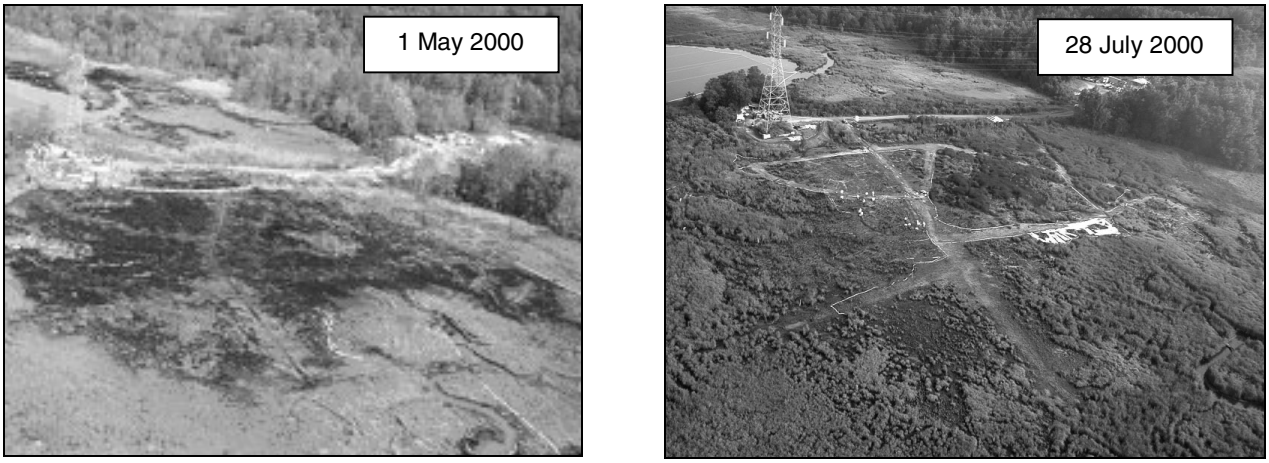



Figure 5. Oblique aerial photographs of Swanson Creek Marsh W01A on a 1 May 2000 and on 28 July 2000 (after completion of planting; some workers and sorbents are still present).

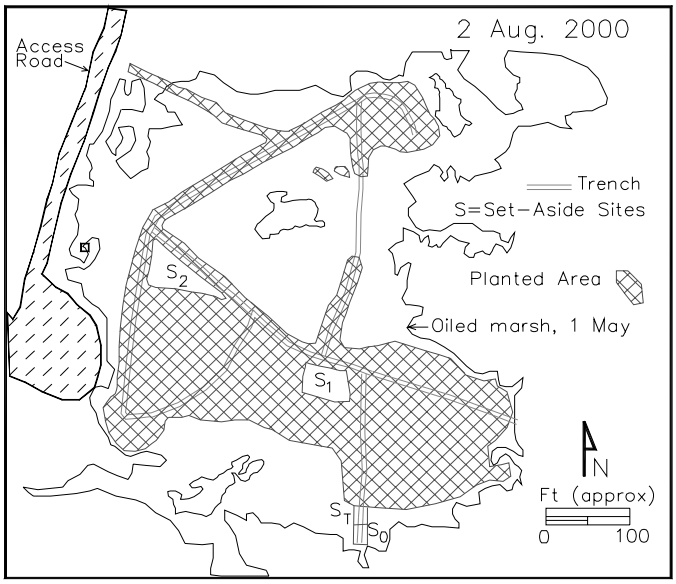



Figure 6. Location of planted areas and set-asides in Marsh W01A. $S_1$ and $S_2$ were heavily oiled/unplanted. $S_T$ = filled trench/unplanted, $S_0$ =unfilled / unplanted trench.

The location of planted and set-aside areas is indicated in Figure 6. The agencies required that unplanted set-aside areas include a 20 ft (6 m) section of trench ($S_T$), a 34x34 ft (11x11 m) square of non-trench ($S_1$), and a location near the pipeline break ($S_2$). A 20 ft (6 m) section of trench was also left unfilled for monitoring purposes ($S_0$).

## Follow-up surveys after 1 and 2 years

On 3 and 4 August 2000, nine 5 ft x 5 ft (1.7 x 1.7 m) quadrats (Q1-Q9) were established to monitor the progress of the repair plantings. Quadrats were located (Figure 7a) throughout the site in all zones except an interior central zone, which was mostly unoiled and showed good growth by July. Quadrats Q1, Q3, Q4, Q5, and Q6 are in previous trench areas, and Quadrats Q2, Q7, Q8, and Q9 are in non-trench areas. Q8 contains *Spartina patens* and all other quadrats contain *S. alterniflora*. Q2 was in an unplanted area. Each quadrat was marked with a painted blue and white striped PVC pole at its top-center and PVC poles at two of its corners. Photo stations were also located throughout the marsh (Figure 7b). Data collected on 3 and 4 August 2000 found that all quadrats had less than 10% plant coverage.

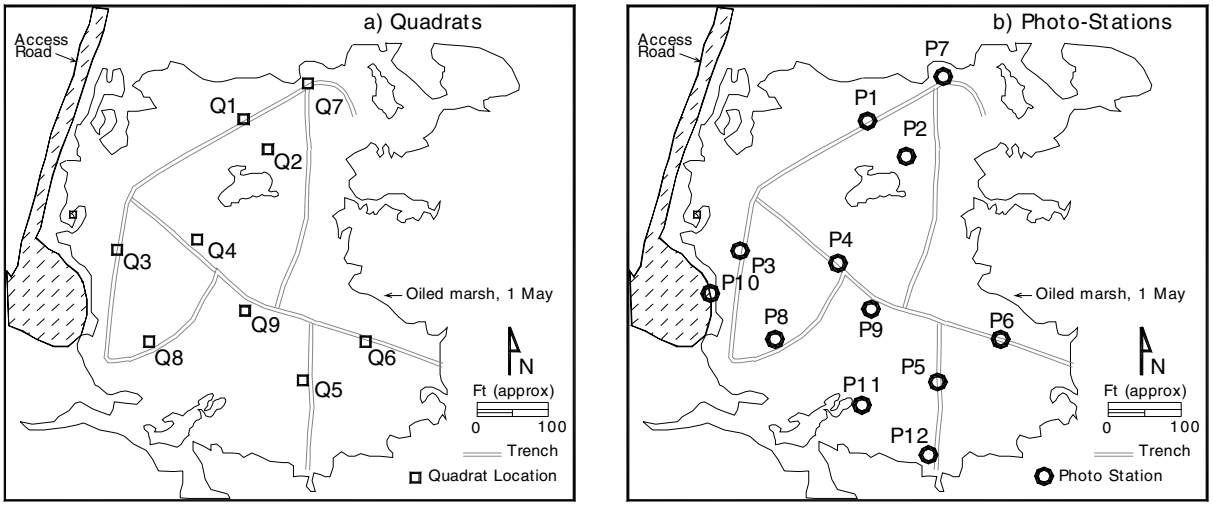
A followup visit to the marsh on 27 June 2001 took pictures of the site, but did not re-occupy the quadrats. From this visit, it was estimated that plant recovery was approximately 70 to 80%. Overview photos of W01A from 2000, 2001 and 2002 are shown in Figure 8. On 16 July 2002, the site was revisited and all quadrats were resurveyed. Data indicate that plants covered 90% of the area, at or near full recovery (Table 3). Figure 9 presents photographs from three quadrats after initial planting in 2000 and then two years later. A series of additional random quadrats was taken across the marsh as well. Data, presented in Table 4,

indicate equally good recovery bearing in mind that this is a typical marsh that contains some open areas where plants do not grow because of channels or sedimentary conditions.

## Impact of replanting on damage assessment compensation

A stated goal of the replanting during the response phase was to aid recovery of the marsh, so it is interesting to review how the damage assessment Trustee Agencies (NOAA, MDNR, MDE, and FWS) looked upon the effort undertaken. If after this effort, no 'credit' is given for replanting then costs to the Responsible Party could be reduced substantially by taking the 'do nothing' approach to avoid the costs of workers, technical specialists, plants, and fertilizer. Unfortunately, the Final Restoration Plan and Environmental Assessment (NOAA et al., 2002) released in November 2002 (after two full growing seasons) indicates that this is the case. NOAA et al. (2002) divide the W01A marsh into two categories. For their 'less impacted' category they base damages on a 10-year vegetation recovery curve (Figure 10) where $time_0$ = 0%, 1 year = 50%, then 5.56% each year for 9 years. We believe that a much faster recovery time is indicated by the data: $time_0$= 50%, 1 year = 90%, and 100% after 2 years (also plotted Figure 10). Additionally, Figure 10 shows actual field data from Michel et al. (2002) for the impacted and reference site areas. Note that actual field data show essentially equal values between the 'less impacted' oiled area and its reference site.

For the 'more impacted' category, the vegetation recovery curve used by NOAA et al. (2002) is also for 10 years, but only 20% recovery after the first year, with then 9 more years to recover fully ($time_0$ = 0%, $time_1$ = 20%, then 8.9% for 9 years). The data provided in this report indicate $time_0$ = 10% (before planting), 75% after 1 year, and 100% after 2 years (see Figure 10 bottom graph). Field data from Michel et al. (2002) are higher than the NOAA et al. (2002) curve, but much below values given in this report for the second year.




(a) (b)

Figure 7. Locations of a) Quadrats and b) Photo stations in Marsh W01A.

**Table 3. Percent coverage of Quadrat sites, 16 July 2002. Each site initially had less than 10% coverage on 4 August 2000 after insert of plant plugs.**

| Quadrats | *S. alterniflora* | *S. patens* | *Scirpus* | *Pluchea /Baccharis* | *Amaranth* | *Typha* | Bare area |
|---|---|---|---|---|---|---|---|
| Planted Q 1 | 90 | 0 | 0 | 0 | 0 | 0 | 10 |
| Unplanted Q 2 | 90 | 0 | 0 | 0 | 5 | 0 | 5 |
| Planted Q 3 | 95 | 0 | 0 | 0 | 0 | 0 | 5 |
| Planted Q 4 | 40 | 0 | 55 | 0 | 0 | 0 | 5 |
| Planted Q 5 | 95 | 0 | 0 | 0 | 0 | 0 | 5 |
| Planted Q 6 | 95 | 0 | 0 | 0 | 0 | 0 | 5 |
| Planted Q 7 | 50 | 0 | 0 | 0 | 0 | 35 | 15 |
| Planted Q 8 | 5 | 95 | 0 | 0 | 0 | 0 | 0 |
| Planted Q 9 | 40 | 0 | 45 | 5 | 5 | 0 | 5 |


Figure 8. W01A marsh, during year of cleanup / replanting and 1 and 2 years after (from photo station P10).

Once the level of injury has been determined (measured in acre-year loss of habitat), appropriate restoration projects can be scaled and budgeted. NOAA et al. (2002) place the cost of replacing the acre-year losses from all marshes at $754,600 to construct a new marsh of 5.7 acres. Based on calculated losses attributable to W01A, we estimate that 35% of this value ($264,110) is derived directly from Marsh W01A, further indicating that NOAA et al. (2002) consider that the replanting was of little to no value in terms of reducing the cost of restoring habitat loss, primarily because of unrecognized actual recovery. Our calculations indicate that the cost of the replanting was roughly $175,000, which includes the higher costs associated with the professional cleanup workers used to undertake the replanting. An offset to this type of the analysis is the consideration that if there really was only 20% plant recovery after 1 year (and 29% after 2 year) in the 'more impacted' W01A marsh, it is difficult to believe that additional replanting would not have been required.

Based on the results shown herein, we believe that replanting during the cleanup operation was correct and resulted in a clear net environmental benefit, and should serve as a model for future marshes impacted by oil.

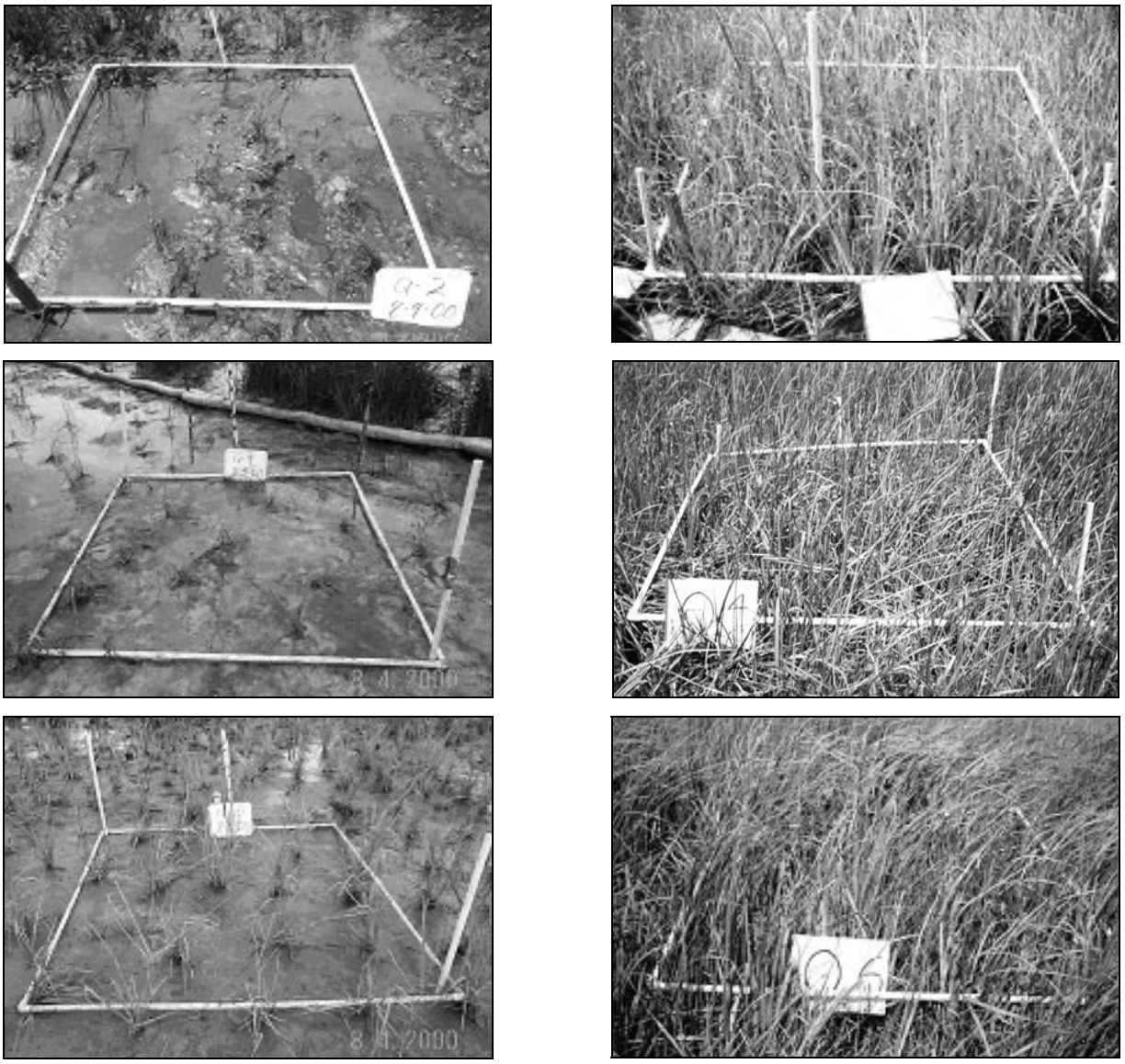
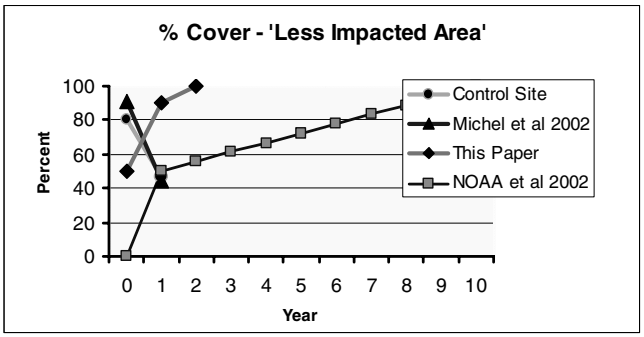


Figure 9. Quadrats 2 (top), 4 (middle) and 6 (bottom). Left side photos are from 4 August 2000. Photos from 16 July 2002 are on the right side.



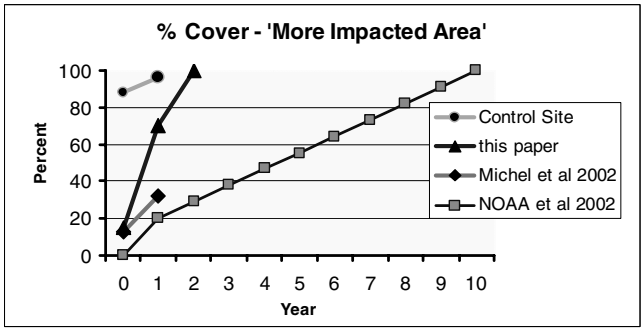




Figure 10. Comparison of recovery data / estimations for 'less' and 'more' impacted areas in W01A marsh (as designated in NOAA et al., 2002)). Control reference is actual site data (average of 3 stations) reported in Michel et al. (2002); this paper refers to data presented herein, Michel et al. (2002) refers to reported field values (average of 3 stations); NOAA et al. (2002) illustrates their recovery curves used to determine marsh acre-year losses and required compensation for damages.

**Table 4. Percent coverage of random quadrat sites, 16 July 2002.**

| Random Quadrat | *S. alterniflora* | *S. patens* | *Scirpus* | *Pluchea /Baccharis* | *Amaranth* | *Typha* | Bare area |
|---|---|---|---|---|---|---|---|
| Planted | 75 | 0 | 20 | 0 | 0 | 0 | 5 |
| Planted | 85 | 10 | 0 | 0 | 0 | 0 | 5 |
| Planted | 85 | 0 | 0 | 0 | 0 | 5 | 10 |
| Planted, SE Lobe | 85 | 0 | 5 | 0 | 0 | 0 | 10 |
| Planted, SE Lobe | 95 | 0 | 0 | 0 | 0 | 0 | 5 |
| Planted, SE Lobe | 98 | 0 | 0 | 0 | 0 | 0 | 2 |
| Planted, SE Lobe | 50 | 0 | 0 | 0 | 0 | 0 | 50 |
| Planted, SE Lobe | 95 | 0 | 0 | 0 | 0 | 0 | 5 |
| Planted, SE Lobe | 90 | 0 | 5 | 0 | 0 | 0 | 5 |
| Planted, SE Lobe | 98 | 0 | 0 | 0 | 0 | 0 | 2 |
| Planted, SE Lobe | 95 | 0 | 0 | 0 | 0 | 5 | 0 |
| Planted, SE Lobe | 95 | 0 | 0 | 0 | 0 | 0 | 5 |
| Planted Trench | 85 | 0 | 0 | 0 | 0 | 10 | 5 |
| Planted Trench | 90 | 0 | 0 | 0 | 1 | 0 | 9 |
| Planted Trench | 80 | 0 | 0 | 0 | 0 | 10 | 10 |
| Planted Trench | 90 | 0 | 5 | 0 | 0 | 0 | 5 |
| Cleaned, not planted | 20 | 0 | 0 | 0 | 1 | 70 | 9 |
| Cleaned, not planted | 70 | 10 | 0 | 0 | 0 | 10 | 10 |
| Heavy Oil unplanted | 7 | 0 | 80 | 1 | 0 | 0 | 12 |
| Unplanted set aside | 70 | 0 | 25 | 0 | 0 | 0 | 5 |
| Unplanted set aside | 70 | 0 | 25 | 0 | 0 | 0 | 5 |
| Cleaned, not planted | 25 | 0 | 25 | 40 | 0 | 0 | 10 |
| Cleaned, not planted | 30 | 0 | 10 | 10 | 0 | 30 | 20 |
| Cleaned, not planted | | 0 | 60 | 40 | 0 | 0 | 0 |
| Cleaned, not planted | 10 | 0 | 90 | 0 | 0 | 0 | 0 |
| Unplanted set aside | 35 | 0 | 10 | 30 | 0 | 0 | 25 |

## References cited

1. Michel, J., J. Hoff, K. Smith, M. Keiler, A. Rizzo and R. Ayella. 2002. Injury to wetlands resulting from the Chalk Point oil spill. Wetlands Assessment Team report to NOAA Damage Assessment and Restoration Program. 8 March 2002. 74 p.

2. NOAA et al., 2002. Final restoration plan and environmental assessment for the April 7, 2000 oil spill at Chalk Point on the Patuxent River, Maryland, November 2002. National Oceanic and Atmospheric Administration, Maryland Department of Natural Resources, Maryland Department of the Environment, and U.S. Fish and Wildlife Service. NOAA Damage Assessment Center, Silver Spring, MD, 138 pp.