COASTAL HIGH MARSH OIL SPILL CLEANUP BY BURNING: 5-YEAR EVALUATION

Larry J. Hyde, Kim Withers, and J.W. Tunnell, Jr.
Center for Coastal Studies, Texas A&M University, Corpus Christi
6300 Ocean Drive
Corpus Christi, Texas 78412

ABSTRACT: *On 7 January 1992, rupture of an underground oil transfer pipeline spilled 2,950 barrels of South Texas light crude oil (API gravity 37) into a high salt-marsh environment along Chiltipin Creek near Bayside, San Patricio County, Texas. The designated state On-Scene Coordinator, the Texas General Land Office (TGLO), after coordination with other resource agencies, authorized* in situ *burning as the primary cleanup technique. Plant frequencies, plant biomass, and hydrocarbon levels in impacted and control areas were monitored between October 1992 and January 1998. Despite severe initial damage, most of the impacted area was revegetated within the first two growing seasons. However, significant differences in vegetation patterns between the two areas continued to exist in January 1998. Linear regression of plant frequency data gives a predicted recovery in the year 2007 (14–15 years post-burn). Plant biomass in the impacted area approximated levels in the control area after only 2 years. Hydrocarbon concentrations in the impacted area remained high after 3 years, but a strong correlation to vegetation patterns over time was not apparent. Results of this study supports the hypothesis that use of* in situ *burning as a response tool has distinct advantages over other countermeasures.*

Preface

This report summarizes research and findings pertaining to a 5-year study of the environmental impact and recovery of the Exxon Pipeline Company oil spill and burn site adjacent to upper Copano Bay, Texas. A 3-year study, funded by the Texas General Land Office (TGLO), was initiated in October 1992 and concluded in October 1995. Three annual reports (Tunnell *et al.*, 1994, 1995a, 1997) and two peer-reviewed papers (Hardegree *et al.*, 1996; Tunnell *et al.*, 1995b) were published while research was ongoing; therefore, conclusions made previously were on work-in-progress. No studies were conducted during Year 4 (January 1996–January 1997). Joint funding from the American Petroleum Institute (API) and TGLO allowed collection of selected data (plant frequencies, biomass, and hydrocarbon data) for Year 5 (April 1997–January 1998). This report consolidates all correlated data from previous studies (October 1992–October 1995) and Year 5, and supersedes previously reported conclusions pertinent to this data.

Introduction

On 7 January 1992, a breech in oil pipeline belonging to the Exxon Pipeline Company, resulted in discharge of approximately 2,950 barrels (468,963 l) of API gravity 37 South Texas light crude oil into 15.5 ha of a high marsh community near Chiltipin Creek, San Patricio County, Texas. Exxon estimated that 1,250 barrels (198,713 l) were recovered from the blow-out hole, 500 barrels (79,485 l) were recovered by pumping, 50 barrels (7,949 l) were recovered in sorbent booms, pads, and pom poms, and 1,150 barrels (182,816 l) remained unaccounted for. The designated On-Scene-Coordinator, TGLO, authorized *in situ* burning of unrecovered oil after consultation with numerous state/federal resource agencies. Their rationale was based on a general consensus that mechanical removal techniques might result in total loss of the existing marsh and that non-removal might pose a continuing threat to the adjacent unimpacted marsh and Aransas River (Tunnell *et al.*, 1997). It was also concluded that below-ground root and rhizome systems would be effectively protected against burn injury by a layer of standing water from recent rainfalls allowing subsequent regrowth in the spring.

Study site

The Chiltipin Creek site is located in San Patricio County, Texas, at approximate coordinates 28°04’09” N, 97°16’01” W (Figure 1). This natural salt marsh is oriented in a northeast and southwest direction approximately 0.8 km southwest of the confluence of Chiltipin Creek and the Aransas River. Two areas were selected for study, one in the impacted marsh (≈15.5 ha) (Tunnell *et al.*, 1997) and one in an unimpacted or control area (≈12.2 ha).

Methods

Assessment of plant recovery in the impacted marsh compared to control levels included utilization of frequency transects, biomass measurements, and aerial photographs. Residual petroleum contaminants in sediments were determined by total petroleum hydrocarbon (TPH) and polycyclic aromatic hydrocarbon (PAH) analysis. In general, these methods remained unchanged from those used by Tunnell *et al.* (1995a, 1997) to evaluate impact and recovery in the marsh between October 1992 and October 1995.

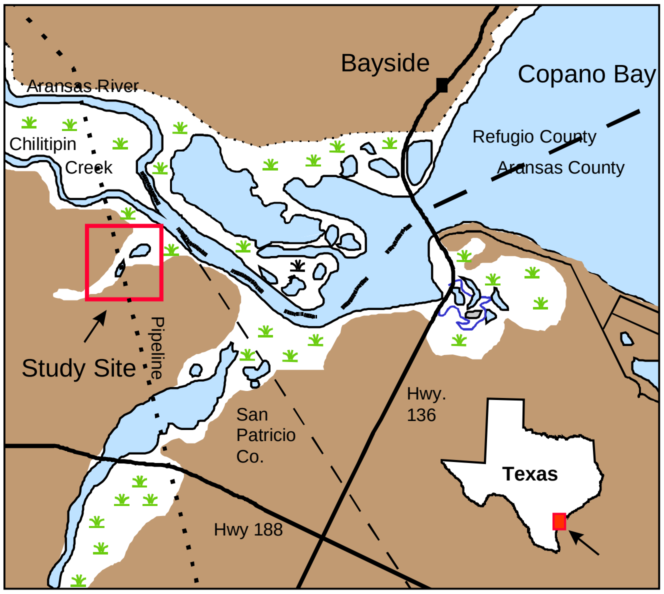


Figure 1. Location of the Chiltipin Creek marsh study site in San Patricio County, Texas (location box on inserted state map is not to scale) (Tunnell *et al.*, 1997).

Results

Diversity of plant species has been consistently higher in the control versus impacted area since October 1992, and significantly higher for all periods except July 1995. Considerable variation in mean percent frequencies for plant species continues to exist between control and impacted areas (Figure 2). In addition, mean percent frequencies for bare area have been consistently and significantly higher in the impacted versus control marsh for all survey periods since October 1992 (Figure 3). Number of transects per study area was increased from 20 to 25 in October 1993. Due to a disproportionate number of bare points on transects added in the impacted compared to control area, a gap in bare area frequency data for 20 versus 25 transects indicated a substantial increase in unvegetated area in the impacted marsh that was not apparent in the control area. Anomalous increases in unvegetated area throughout the marsh during this study may be explained by a severe drought in 1996, feral hog wallows observed in the impacted area during April 1997, and vegetation loss throughout the marsh between April 1997 and October 1997 due to direct damage caused by the activities of seismic crews. A tentative "balance" in biomass values was reached in 1995 and maintained through the first half of this study, but deteriorated to significant imbalance during the second half of this study; reflecting, perhaps, increased vulnerability of the impacted marsh to the recent perturbations cited above. However, a general increase in biomass values for both control and impacted areas occurred between 1995 and survey periods included in this study.

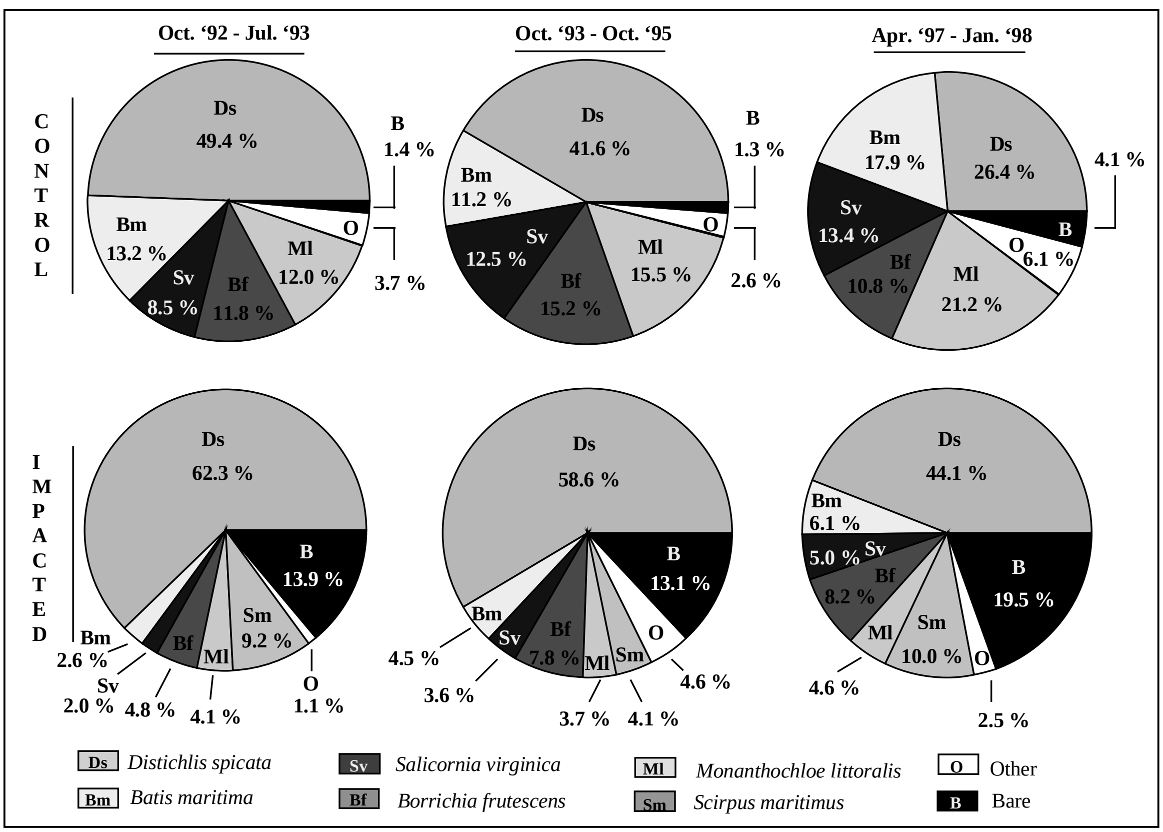


Figure 2. Mean percent frequencies for ten plant species (four species in "other") and bare area in control and impacted areas of Chiltipin Creek marsh for October 1992–July 1993, October 1993–October 1995, and April 1997–January 1998.

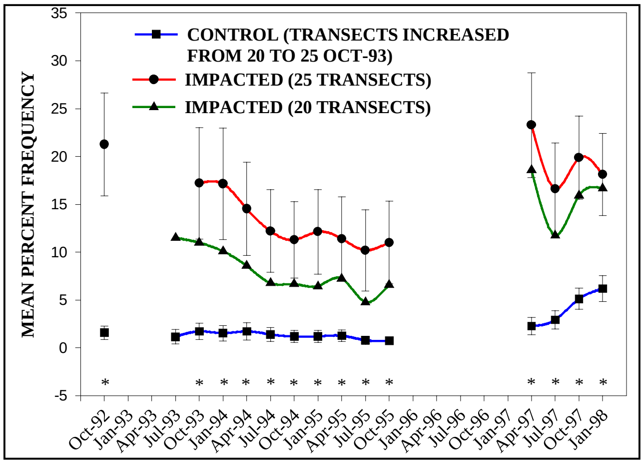


Figure 3 Comparison of quarterly mean frequencies for bare area between impacted and control sites in Chiltipin Creek marsh from October 1992 through July 1993 (20 transects per site) (Tunnell *et al.*, 1994), October 1993 through July 1995 (20 versus 25 impacted transects compared to 25 control transects) (Tunnell *et al.*, 1997, revised), and from October 1995 through January 1998 (20 versus 25 impacted transects compared to 25 control transects). *Significantly different (comparison between maximum number of transects in control and impacted areas for any given period) ($P < 0.05$).

Aerial photographs taken in February 1988, July 1995 (Tunnell *et al.*, 1997), and August 1997 indicate an increasing trend in estimated bare area (2.4 ha, 3.0 ha, and 5.6 ha respectively) in the impacted marsh. The increase between 1988 and 1995 is obviously explained by the oil spill/burn in January 1992, while the anomalous increase between 1995 and 1997 is probably a result of recent perturbations described above.

Decreasing trends in mean hydrocarbon concentrations (TPH and PAH) in the impacted marsh occurred between December 1992 and July 1997. This trend was not significant for TPH samples (Figure 4). A sharp increase in TPH values for July 1994 is explained by conversion from an infrared to gas chromatographic technique. The trend for PAH samples was not significant until July 1997, when a large decrease was determined (Figure 5). Inconsistent correlation between hydrocarbon values and the state of vegetative cover in the impacted marsh preclude a clear understanding of oil related plant recovery rates in this study.

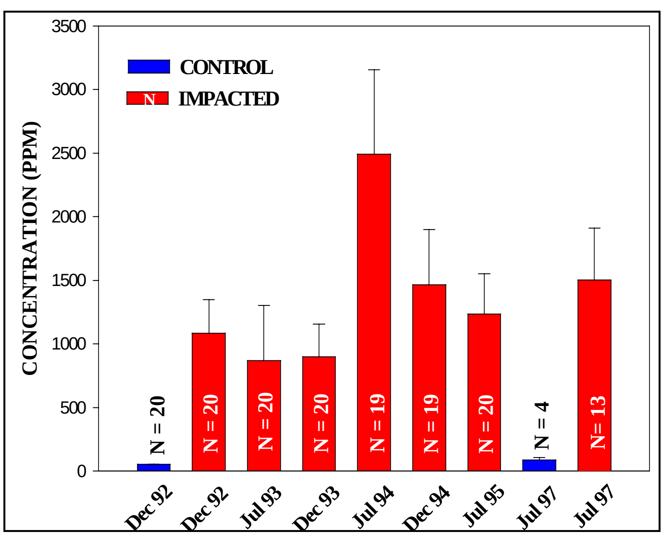


Figure 4. TPH concentrations in control and impacted areas of Chiltipin Creek marsh using IR analysis for samples collected in December 1992 through December 1993 (Tunnell *et al.* 1995b), and GC analysis for samples collected in July 1994 through July 1995 (Tunnell *et al.*, 1997) and July 1997 (N = number of samples).

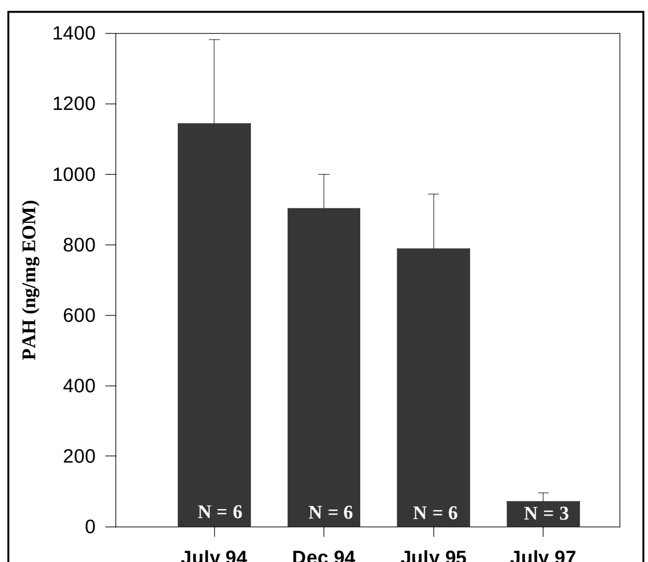
Conclusions

1. There are two possibilities regarding the present state of recovery. One, the impacted marsh is fully recovered. Current differences between control and impacted areas are a reflection of "normal" pre-spill burn conditions as a result of physical differences between the two areas (e.g., elevation, hydrology, soil salinity). Two, the impacted marsh is still in a process of slow recovery, suggested by a linear regression predicting full recovery in the year 2007 (Figure 6).
2. Tunnell *et al.* (1997) reported that the burn caused severe initial plant damage/loss, but also documented progressive recovery of impacted plant communities and apparent degradation of hydrocarbon residues to a benign form over a 3-year period. They concluded that the burn probably allowed a more rapid recovery compared to mechanical or "do nothing" approaches. In general, the results of this study lend support to this previous conclusion.

Biography

Larry J. Hyde is a Biology Masters of Science Candidate in the College of Science and Technology at TAMU-CC. He has worked in the fields of marine and estuarine ecology in the northwestern Gulf of Mexico since 1987: TAMU-CC (1992–1998), Louisiana Universities Research Consortium (1990–1992), and TAMU-Galveston (1987–1989).

Figure 5. PAH concentrations within a small unvegetated



area (approximately 2 m^2) in the vicinity of the January 1992 pipeline rupture in the impacted portion of Chiltipin Creek marsh (N = number of sediment samples).

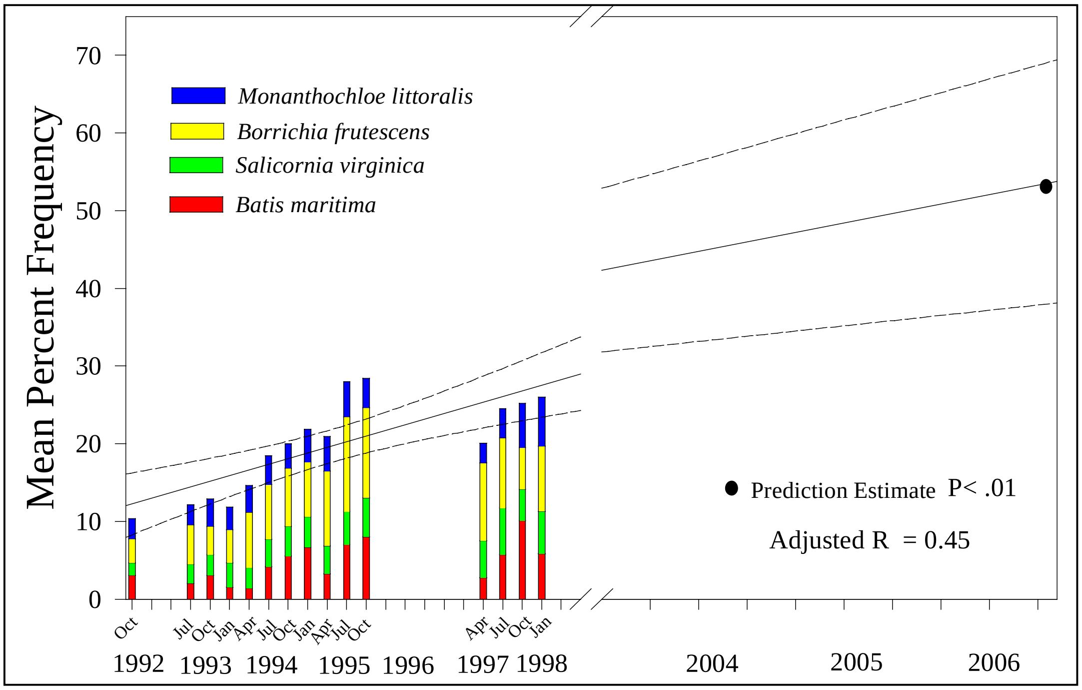


Figure 6. Combined mean frequencies of "climax vegetation species" observed in the impacted area of Chiltipin Creek marsh, October 1992–October 1995 (Tunnell *et al.*, 1997) and April 1997–January 1998 with predicted time for impacted frequency levels to approximate those observed in the control site.

References

1. Hardegree, B., D. W. Hicks, and J. W. Tunnell, Jr. 1996. Evaluation of burning as an oil spill cleanup technique in a high marsh community along the south Texas coast. Pages 195-211 *in* Proffitt, C. E. and P. F. Roscigno (eds.), Proc. Gulf of Mexico and Caribbean oil spills in coastal ecosystems: assessing effects, natural recovery and progress in remediation research. OCS Study/MMS 95-0063. US Dept. of Interior, Minerals Management Service, Gulf of Mexico OCS Region. New Orleans, Louisiana.
2. Tunnell, J. W. Jr., D. W. Hicks, and B. Hardegree. 1994. Environmental impact and recovery of the Exxon Pipeline oil spill and burn site, upper Copano Bay, Texas: Year 1. Texas A&M Univ. - Corpus Christi, Center for Coastal Studies, Tech. Report TAMU-CC-9402-CCS. Corpus Christi, Texas. 75 pp.
3. Tunnell, J. W., Jr., B. Hardegree, and D. W. Hicks. 1995a. Environmental impact and recovery of a high marsh pipeline oil spill and burn site, upper Copano Bay, Texas. Pages 133-138 *in* Proc. 1995 Oil Spill Conference, American Petroleum Institute. Washington, D. C.
4. Tunnell, J. W., Jr., B. Hardegree, K. Withers, and D. Hicks. 1995b. Environmental impact and recovery of the Exxon Pipeline oil spill and burn site, upper Copano Bay, Texas: Year 2. Texas A&M Univ.-Corpus Christi, Center for Coastal Studies, Tech. Rept. TAMU-CC-9501-CCS. Corpus Christi, Texas.
5. Tunnell, J. W., Jr., K. Withers, and B. Hardegree. 1997. Environmental impact and recovery of the Exxon pipeline oil spill and burn site, upper Copano Bay, Texas: Final Report. Texas A&M Univ.-Corpus Christi, Center for Coastal Studies, Tech. Rept. TAMU-CC-9703-CCS. Corpus Christi, Texas.