Bull. Environm. Contam. Toxicol. 23,800-805 (1979)

Resuspension of Oil: Probable Cause of Brown Pelican Fatality

Kirke A. King[1], Stephen Macko[2], Patrick L. Parker[2], and Emilie Payne[3]
[1]U. S. Fish and Wildlife Service, Patuxent Wildlife Research Center, Gulf Coast Field Station P. O. Box 2506, Victoria, Texas 77901, [2]University of Texas, Port Aransas Marine Laboratory, Marine Science Institute, Port Aransas, Texas 78373, and [3]326 Camellia, Corpus Christi, Texas 78404

Coastal ecosystems are vital nesting and wintering areas for numerous bird populations. Increasing growth in coastal areas, particularly development related to the recovery and transportation of oil, poses severe threats to coastal and marine bird species. The devastating effects of oil spills on waterbirds are now well documented; large numbers of marine birds die each year as a result of oil spills (BOURNE et al. 1967, ALDRICH 1970, VERMEER and VERMEER 1974, and OHLENDORF et al. 1978). Most mortality occurs within a few days after the spill; however, our recent observations in Texas indicate that mortality may occur at least 6 weeks after the original spill.

On 26 November 1976, an adult brown pelican *(Pelecanus occidentalis)* was found floating helplessly in Corpus Christi Bay. About 90 to 95% of its feathers were lightly coated with oil. The bird died the following night. A necropsy performed by the U. S. Fish and Wildlife Service Health Laboratory, Madison, Wisconsin showed no signs of gross pathology.

A total of 46 oil spills were reported in the Corpus Christi - Redfish Bay vicinity between 1 October 1976 and 26 November 1976 (U. S. COAST GUARD, unpublished records). Only six of these spills involved oil in quantities greater than 1 barrel. Of these six spills, two were in areas frequented by brown pelicans. Both spills occurred 6 to 7 weeks before the oiled pelican was recovered from Corpus Christi Bay.

On 7 October 1976 a 10 barrel oil spill was reported at Aransas Pass, but no extensive environmental impacts were associated with that spill. On 13 October 1976 a pipeline ruptured spilling 377 barrels of oil into Redfish Bay (Fig. 1) at Harbor Island (HOLT et al. 1978). Cleanup operations began 13 October 1976 and were completed the afternoon of 14 October 1976. An estimated 80 to 85% of the oil was recovered (HOLT et al. 1978).

Before cleanup operations were completed, an east wind and incoming tide moved much of the spilled oil into the cordgrass *(Spartina alterniflora)* and black mangrove *(Avicennia germinans)* marsh at the southeast end of Redfish Bay. The oil was carried well into the marsh by the relatively high tide and strong winds. The heavy concentrations of petroleum were the source of a thin film that covered most of the open water in

0007-4861/79/0023-0800 $01.20

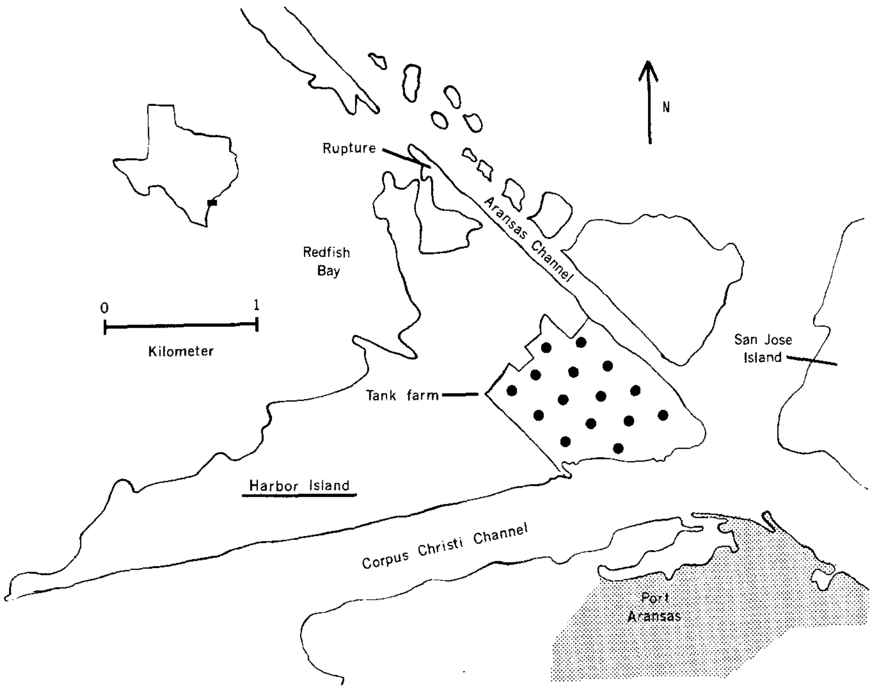

Fig. 1. Location map: Harbor Island oil spill.

the marsh. Thirty days after the spill, oil was observed on the stems of the cordgrass, on the aerial roots, stems, and leaves of mangroves and on exposed mud flats. Surface waters in the intertidal areas were free of petroleum but a layer of oil was present about 1 cm below the sediment surface. Light pressure or digging in these muddy sediments released oil trapped in the substrate (HOLT et al. 1978). Oil spilled in salt marshes may persist for long periods (MAYO et al. 1978, TEAL et al. 1978). Sheltered environments such as salt marshes and mangroves are the areas most likely to be affected by oil spills; residence times of over 10 years are predicted for some salt marsh areas (GUNDLACH and HAYES 1978).

Samples of crude oil were taken on the day of the spill at Harbor Island and oil contaminated sediment samples were collected at regular intervals for up to 2 years following the spill. We compared the chromatograms of the oil extracted from the marsh sediments that were collected about 4 and 8 weeks after the spill with samples of oil scraped from the pelicans feathers. Oiled feathers clipped from the pelican were compared to clean feathers from a zoo-raised brown pelican and also to the oil collected from the marsh.

Chemical analyses of the oil samples were completed at the University of Texas, Marine Science Institute, Port Aransas, Texas laboratory. Methanol:toluene extracts of oil from marsh sediments and from the oiled brown pelican were concentrated and separated into a hexane eluate and a benzene eluate by column chromatography on silica gel: alumina (2:1 vol.). The constituents of these eluates were then quantified by gas chromatography (SP 1000 glass capillary, Perkin-Elmer model 910 with FID) and the components identified by GCMS (Dupont Instruments 21-491 GCMS/21-094B Data System). Stable isotope measurements of the crude extract were completed on an isotope ratio mass spectrometer (Nuclide Corp. Model RMS-60) relative to the PDB standard.

Sediment samples collected at 4 to 8 weeks after the Harbor Island pipeline rupture contained more than 100 ppm oil. Chromatograms of oil extracted from these marsh sediments were almost identical. Feathers clipped from the oiled brown pelican contained up to 5% petroleum (dry weight). A comparison of gas chromatograms of the hexane eluate (Fig. 2) and the benzene eluate (Fig. 3) showed several similarities. The fine structures of the hexane eluate (unidentified peaks between C_{14} and C_{15}, C_{15} and C_{16}, C_{16} and C_{17}, and C_{17} and C_{18}) were almost identical. The pristane/phytane (PR/PH) ratio (Table 1) was also nearly identical. The large unresolved complex mixture (UCM) in the oiled feather sample (Fig. 2) may be a result of many natural products extracted in addition to the oil since chromatograms of the extracts of uncontaminated pelican feathers showed a similar UCM. The odd-even predominances (OEP) plots (Fig. 4) indicated petroleum as the primary source of the extract. The benzene eluate showed the presence of substituted (C_1, C_2, and C_3) naphthalenes and phenanthrenes in both samples. A comparison of concentration ratios of these materials are shown in Table 1. Also, stable carbon isotope analysis indicated that the oils were similar or were the same. The oil $\delta^{13}C$ was -27.3 and the extract from the oiled brown pelican feathers was -27.9. The clean feather extracts were on the order of -23.0. These data indicate that the oil extracted from the pelican's feathers closely resembles oil found in the sediment and may, in fact, be that oil.

The death of an individual of an endangered bird species 6 weeks after the original spill emphasizes that not all mortality associated with oil spills is immediate and obvious. Oil spilled in salt marshes persists for long periods; consequently special attention must be paid to these areas. Resuspension of oil trapped in pools or in sediments can result in the recontamination of adjacent waters (VANDERMEULEN and GORDON 1976). This is the first instance of which we are aware that resuspended oil may have resulted in bird mortality.

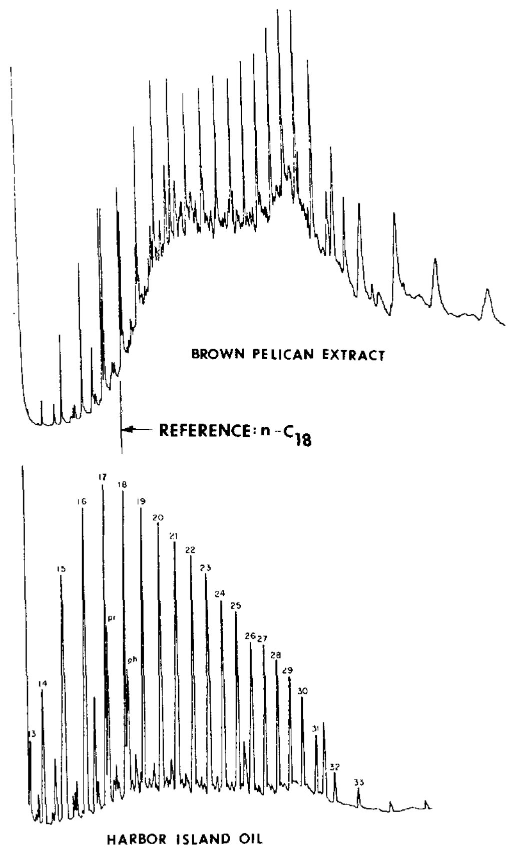

Fig. 2. Hexane eluate chromatograms: 8 week-old sediment oil and oil from brown pelican feathers.

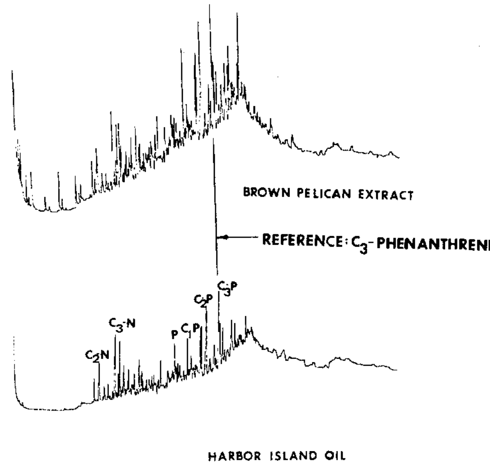

Fig. 3. Benzene eluate chromatograms: 8 week-old sediment oil and oil from brown pelican feathers. N= Naphthalene, P= Phenanthrene.

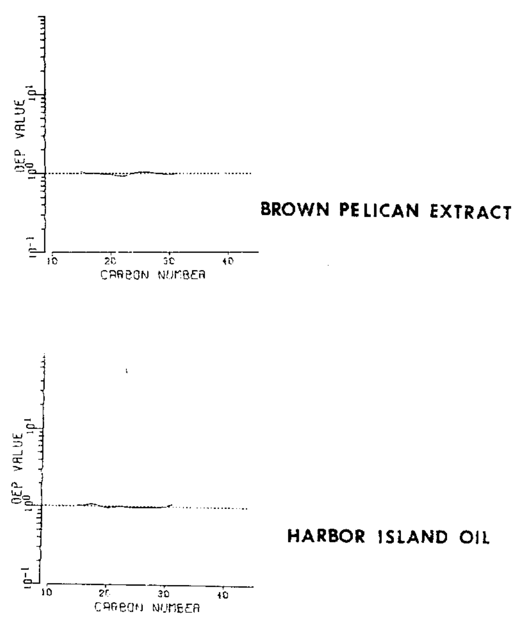

Fig. 4. Comparison of odd-even predominances: 8 week-old sediment oil and oil from brown pelican feathers.

TABLE 1

Comparison of 8 week-old weathered oil collected from Redfish Bay saltmarsh sediments with oil extracted from the feathers of a brown pelican.

Components	Weathered oil	Oil from pelican feathers
Pristane / Phytane	1.30	1.27
Phenanthrene / 3-Methylphenanthrene	0.91	0.87
3-Methylphenanthrene / 2-Methylphenanthrene	0.92	0.94
Phenanthrene / Dimethylphenanthrene	0.58	0.60

Acknowledgments: We thank the U. S. Coast Guard for access to their files on oil spills. We are grateful to D. White, N. Coon, and M. Gay for review of this manuscript and to C. Glenn for typing the manuscript.

REFERENCES

ALDRICH, J. W.: U. S. Fish Wildl. Serv. Resour. Publ. 87 (1970).

BOURNE, W. R. P., J. D. PARRACK, and G. R. POTTS: Nature 215, 1123-1125 (1967).

GUNDLACH, E. R., and M. O. HAYES: Mar. Technol. Soc. J. 12, 4 (1978).

HOLT, S., S. RABALAIS, N. RABALAIS, S. CORNELIUS, and J. S. HOLLAND: *In* Proc. of Conference on Assessment of Ecological Impacts of Oil Spills. 14-17 June 1978. Keystone, Colo. (1979).

MAYO, D. W., D. S. PAGE, J. COOLEY, E. SORENSEN, F. BRADLEY, E. S. GILFILLAN, and S. A. HANSON: J. Fish Res. Board Canada 35, 5 (1978).

OHLENDORF, H. M., R. W. RISEBROUGH, and K. VERMEER: U. S. Fish Wildl. Serv., Wildl. Res. Rept. 9 (1978).

TEAL, J. M., K. BURNES, and J. FARRINGTON: J. Fish. Res. Board Canada 35, 5 (1978).

VANDERMEULEN, J. H., and D. C. GORDON, JR: J. Fish. Res. Board Canada 33, 9 (1976).

VERMEER, R., and K. VERMEER: Can. Wildl. Serv. Manuscr. Rept. 29 (1974).