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SCIENCE DIRECT
Marine Pollution Bulletin 52 (2006) 778–789
MARINE POLLUTION BULLETIN
www.elsevier.com/locate/marpolbul

Characterization and source of oil contamination on the beaches and seabird corpses, Sable Island, Nova Scotia, 1996–2005

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Abstract

During April 1996–May 2005, 2343 oiled seabird corpses were recorded in beach surveys conducted on Sable Island, Nova Scotia. One hundred eighty-three samples of oil were collected from the beaches and from the feathers of bird corpses. Gas chromatographic (GC/FID) analysis was used to identify generic oil type and likely marine source. During this period, at least 74 marine oil discharge events were probably responsible for beached pelagic tar and contamination of seabird corpses found on Sable Island, of which 77.0% were crude oils, 14.9% were fuel oils, and 8.1% were bilge oil mixtures. While fuel and bilge oils may be discharged by all vessel and platform types, crude oil discharges are associated with tanker operations. This study demonstrates that oiling of the sea from tankers remains a serious wildlife issue in the Northwest Atlantic.

Keywords: Oil pollution; Oil identification; Shipping; Tanker operations; Monitoring; Beached bird surveys; Northwest Atlantic; Sable Island

1. Introduction

Oil enters the marine environment from natural seeps, land runoff, vessels, pipelines and offshore petroleum exploration and production platforms. Common sources of oil pollution in the offshore North Atlantic region are marine shipping activities, offshore oil and gas operations, and long-range industrial transport (National Research Council, 2003). Marine shipping activities discharge oil by several processes: catastrophic losses during accidents, periodic discharges from poor or illegal tanker operations, and chronic bilge discharges from general cargo vessels or other vessels.

Discharges, such those associated with the *Erika* and *Prestige* disasters, are rare, but when they do occur, they generally result in the release of crude oil. However, in the offshore waters of Atlantic Canada, catastrophic spills which occurred during accidents involving the tanker *Arrow* (1970), the oil-barge *Irving Whale* (1970), and the tanker *Kurdistan* (1979) (Brown, 1991), resulted in discharges of fuel oil. During the 1996–2005 study period, only one catastrophic discharge occurred in the region. The *Flare*, which broke up roughly 200 km east of Cape Breton, Nova Scotia, in 1998, was a bulk grain carrier with an estimated 650 metric tonnes of fuel and lube oil on board (R. Percy, Environment Canada, personal communication). In terms of tonnes of oil, total spillage from such catastrophic incidents is generally less than that released as illegal discharges associated with tank washings, dirty ballast and bilge pumping (National Research Council, 2003; GESAMP, 2004).

Discharged crude oils originating from tankers can be contaminated with distillate fuel oils such as diesel that is used as a cleaning solvent for removing residues of crude oil from vessel cargo tanks. Such tank washings are held in slop tanks, but may ultimately be discharged to the ocean to avoid the cost of disposing ashore at an approved oil reception facility. Vessels of all types may also discharge bilge waters containing mixtures of lube and fuel oils (Bunker or distillates). Some container ships operate on heavier

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0025-326X/$ - see front matter © 2005 Elsevier Ltd. All rights reserved.
doi:10.1016/j.marpolbul.2005.11.023

fuel oils (e.g. Bunker oils) on long runs but switch to lighter fuel oils when operating near port regions. Heavy fuel oils leave residues in the tanks that must be periodically removed, sometimes by washing with a light fuel oil. If discharges of this residue occur the resulting oil may be characterized as Bunker fuels containing lighter fuel oils such as diesel.

Discharges from offshore oil and gas operations (exploration and production platforms) on the Scotian Shelf could include light crude oils such as condensate, and specialty products that may contain oil (e.g. drilling fluids).

Marine discharges of oil, exposed at sea for many weeks to months, would generally be observed in Scotian Shelf waters as "pelagic tar". Highly weathered pelagic tars, or "tarballs", are floating balls of tar 5–150 mm diameter, having a weathered hard exterior, and less weathered semi flowable interior (Van Vleet et al., 1984; Savage and Ward, 1984; Butler et al., 1998). The weathered outer coating of tarballs at sea makes them less likely to adhere to bird feathers, but they reflect the occurrence of oiling events on the sea surface.

Sable Island (44N, 60W), the emerged portion of the Sable Island Bank on the outer edge of the Scotian Shelf, is situated in a region with a high level of marine traffic heading to and from ports in Atlantic Canada, the St. Lawrence Seaway, the United States, and Europe (Fig. 1). The island is surrounded by major shipping routes, with concentrations of activity southwest through northwest of the island (Lock et al., 1994; Wiese and Ryan, 2003). Vessels on the shipping lanes are thought to discharge significant amounts of oil into the Northwest Atlantic (Chardine, 1991; Wiese and Ryan, 2003; National Research Council, 2003). Also, the Sable Island Bank is at the centre of development and production of offshore petroleum resources (now primarily gas) on the Scotian Shelf, with production platforms located south, southwest and east of the island.

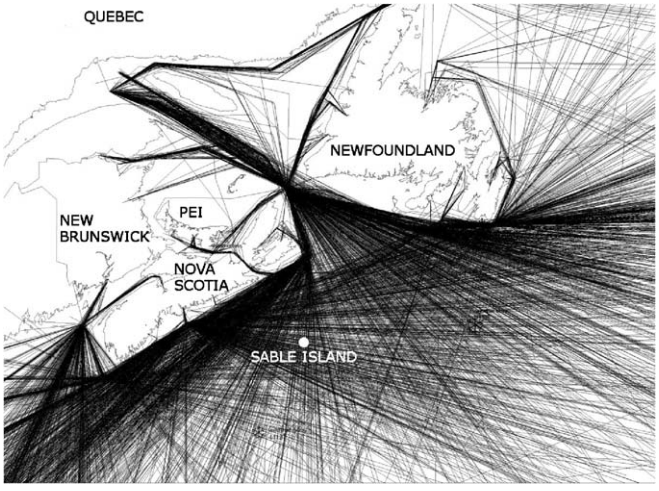

Fig. 1. Typical annual ship track pattern of container, cargo and tanker vessels travelling to or through Atlantic Canada destined to Canadian ports during 1990–2000 (adapted from Wiese and Ryan, 2003).

Sable Island's unique offshore location and proximity to areas of heavy marine traffic and energy production activities make it a useful platform for monitoring marine issues (e.g. Lucas, 1989; Lucas and Hooker, 2000; Lucas and Daoust, 2002). Since 1993, surveys for beached oiled birds have been conducted on the island (Lucas, 2003). This paper presents the results of gas chromatographic analysis used to generically identify oil types in samples of pelagic tar and oiled feathers recovered from the beach and from oiled seabird corpses during beach surveys conducted during 1996–2005. Improved scientific knowledge of sources of oil discharges to the Northwest Atlantic could help guide effective pollution policies and monitoring, and enable regulators to target surveillance on vessel types most commonly suspected of discharging oil at sea.

2. Methods

2.1. Field methods

Sable Island is a 45 km-long sand bar with a maximum width of roughly 1.5 km. The shoreline comprises long uninterrupted sand beaches on both the north and south sides. Surveys for beached oil and oiled seabirds were usually conducted once every 30–40 days, and observations were made during routine travel on the beach between surveys. Species identification, corpse condition and extent of oiling were recorded for seabird specimens. When possible, the time since death was estimated based on freshness of tissues and degree of scavenging. The oiling rate is the fraction of oiled birds of the total number of dead birds, intact and otherwise, found on the beach.

Samples of beached pelagic tar and oiled feathers, representing contamination on various seabird species, and at various beach locations on the island, were collected. A sample set comprised one or more samples collected during a beached bird survey, or during an interval between surveys. An attempt was made to sample from the freshest specimens (i.e. the most recently oiled) based on condition of the corpse and the development of crust formed by sand adhering to the oil. The samples were packaged in aluminium foil or in glass jars, labelled, kept frozen for periods ranging from one week to three months, and delivered to the laboratory for gas chromatographic analysis (Seatech Ltd, now Maxxam Analytics, Bedford, Nova Scotia). Samples of oil found on the beach and bird corpses on Sable Island were identified as representing separate discharge events on the basis of date, bird corpse condition, and oil characteristics.

2.2. Laboratory methods

2.2.1. Analysis of oil specimens collected on Sable Island

All oil specimens were solid samples (pelagic tar or oiled seabird feathers) and were dissolved directly in dichloromethane. This extract, filtered to remove solids, was injected on a glass capillary column (SPB-1) in an HP