TANK VESSEL OPERATIONS, SEABIRDS, AND CHRONIC OIL POLLUTION IN CALIFORNIA

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SUMMARY

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This paper reviews the recent history of oil-spill related seabird mortality events in California and assesses the potential threat of chronic oil pollution from regular shipping practices. Only a small percentage of large spill events have been due to tanker accidents. The vast majority of spills have been associated with non-tanker vessels and pipelines. Tankers, however, pose a constant threat of small-scale oil pollution associated with illegal dumping of oily waste. Shipping practices are explored in detail, enabling an informed assessment of the risk to various seabird species.

Key words: oil-spill, mortality, oil tanker, California

INTRODUCTION

During the 20th century, hundreds of thousands to millions of seabirds, especially Common Murres *Uria aalge*, were killed by oil pollution from oil tankers and other marine vessels in central California (see reviews in Burger & Fry 1993; Carter *et al.* 1998, 2001, *in review a, b*; Carter 2003). Early in the century, San Francisco Bay developed into one of the largest ports in California with high traffic of oil tankers and other commercial and military vessels. Oil pollution largely occurred in the Gulf of the Farallones from vessel collisions and other accidents, as well as operational discharges as vessels approach and depart from San Francisco Bay. Prior to the 1970s, oil spills were recorded sporadically and seabird mortality was rarely assessed, except during the 1937 *Frank H. Buck* oil spill (Aldrich 1938; Moffitt & Orr 1938). However, after the 1971 San Francisco oil spill (Smail *et al.* 1972), efforts to document oil spills and seabird mortality improved. During the 1984 *Puerto Rican* and 1986 *Apex Houston* oil spills, seabird mortality was well assessed in central California, using models that incorporated data from beached bird surveys, tallies of birds entering rehabilitation centers, and aerial at-sea surveys (Ford *et al.* 1987; Page *et al.* 1990; Carter *et al.* 2003).

Following major tanker oil spills in Alaska in 1989 and in California in 1990, state and federal legislation mandated many new oil spill prevention measures. The advent of harbor vessel tracking systems, tug escorts, off-shore tanker routing, certificates of financial responsibility, requirements for double hull tankers, inspections and spill contingency plans have contributed to a dramatic decline in tanker-related spills. Awareness of the significant costs of oil spill clean-up and the threat of criminal and civil financial liability may have influenced industry performance standards. Although about 650 million barrels of petroleum products are transferred through California waters annually, only one significant seabird mortality event has been attributed to a tanker spill in California since 1990 (i.e., 1998 *Command* oil spill; Table 1). In contrast, non-tanker vessel spills, oil pipeline breaks, and chronic oil pollution have killed thousands of seabirds since 1990. Since 1984, at least twelve major oil spills have resulted in large numbers of oiled birds (Table 1), but only three of these spills have involved tankers, only two of which were accidents.

NON-TANKER SPILLS

The twelve spills listed in Table 1 show two significant facts: 1) oil spills may occur due to a remarkable variety of circumstances; and 2) small volumes of oil may kill large numbers of birds. Accidents regarding non-tanker vessels are the most common. The *Apex Houston* was a barge that leaked fuel due to a missing hatch cover. The *Stuyvesant*, a large dredge, and the Kure, a cargo vessel, experienced accidents that punctured bunker fuel tanks. The *Cape Mohican* was a vessel in dry dock when a compartment containing bunker fuel was accidentally drained, spilling it onto the dock and into San Francisco Bay. The Pt. Reyes Tarball Incidents and the San Mateo Mystery Spill have both been linked to the wreck of the *Jacob Luckenbach*, a cargo vessel that sunk in 1953. The Platform Irene spill was the result of a break in an undersea pipeline that carries crude oil from an offshore drilling platform to an onshore facility. Only the *Puerto Rican*, *American Trader*, and *Command* are tanker vessels. The *Puerto Rican* suffered an explosion in a cargo tank three miles off the Golden Gate and eventually broke in two. The *American Trader* accidentally ran over its own anchor in shallow water, puncturing a tank. The *Command* deliberately discharged residual waste oil at sea (discussed below).

TANKER-RELATED CHRONIC OIL POLLUTION

It is often estimated that the amount of oil released into oceans by tanker vessels as a result of operational discharges greatly exceeds the amount released during accidental spills (Shaw *et al.* 1987). The International Conference on Marine Pollution: Convention for the Prevention of Pollution from Ships 1973 and the related 1978 Protocol (MARPOL) attempted to address this problem. Indeed, the ultimate stated goal of MARPOL is "the complete elimination of intentional pollution of the marine environment by oil and other harmful substances…". This is an ambitious endeavor, considering that MARPOL is an international agreement regarding the behavior of individuals and corporations traveling the high seas. The establishment of shipping rules and standards has been subject to compromise among signatory nations, and enforcement is difficult. Nevertheless, MARPOL has been remarkably successful in reducing oil pollution. It is estimated that operational discharges of oil dropped 85% between 1973 and 1990 (Griffin 1994). However, chronic oil pollution remains a problem that affects seabirds and other marine life in many places (Wiese 2002, Lock & Deneault 2000). Under 1992 amendments to MARPOL, vessels may discharge oil into the ocean at a rate of 30 liters per nautical mile (16 liters per km), as long as they are greater than 80 km from shore. The evidence suggests that it is common practice for vessels to exceed this limit (Gade & Alpers 1999, Lu *et al.* 2000, Lock & Deneault 2000).

SHIPPING OPERATIONS AND TANK WASHINGS

There used to be two major sources of operational discharges: oil contaminated ballast water and cargo tank washings. When tankers offload cargo and prepare to travel empty, they must take on large quantities of ballast water to maintain the proper balance of the ship at sea. Historically, tankers would store much of this ballast water in empty cargo tanks. Because these tanks contained oily residues, the ballast water became contaminated. When the ballast water was discharged, several thousand gallons of oil would be released as well. This problem, however, has largely been solved by the evolution of Segregated Ballast Tanks (SBTs), tanks that are designated for ballast water only. All but the oldest tankers in use today employ SBTs.

Cargo tank washings thus remain the greatest oil spill threat to seabirds, aside from catastrophic accidents. Each week approximately 10 tankers arrive at ports in California, while an equal number depart. Most of these tankers are bringing crude oil into the state from Valdez, Alaska. However, approximately a third of them are importing crude oil or other refined oils from other parts of the world (such as Asia, Australia, South America, Africa, or the Middle East). Once they arrive at a California port, there are a number of possibilities regarding what they might do next. They may leave empty to retrieve more of the same cargo. This is typically the case with the Trans Alaska Pipeline tankers (TAPS),

TABLE 1
Major oil spill-related seabird mortality events since 1984

Incident	Date	Location (county)	Cause of oil release	Amount spilled (l)	# of birds collected
Puerto Rican	Nov, 1984	Sonoma-San Mateo	Tanker accident	5,400,000	1,368
Apex Houston	Feb, 1986	Sonoma-Monterey	Oil barge accident	97,650	4,198
American Trader	Feb, 1990	Orange	Tanker accident	1,570,000	914
Cape Mohican	Oct, 1996	San Francisco	Non-tanker vessel accident at dock	151,400	257
Torch/ Platform Irene	Sept, 1997	Santa Barbara	Offshore platform pipeline break	26,500	140
Kure	Nov, 1997	Humboldt	Non-tanker vessel accident at dock	17,000	951
Pt. Reyes Tarballs (Luckenbach)	Nov-Feb, 1997-1998	Sonoma-Monterey	Leaking sunken non-tanker vessel	< 35,000?	2,955
Command	Sept-Oct, 1998	San Mateo	Tanker deliberate dump	13,250	177
Stuyvesant	Sept, 1999	Humboldt	Non-tanker vessel accident	9,500	1,205
San Mateo Mystery (Luckenbach)	Nov-Apr, 2001-2002	Sonoma-Monterey	Leaking sunken non-tanker vessel	< 35,000?	1,921
Luckenbach Response	Summer, 2002	Sonoma-Monterey	Cleanup actions of sunken non-tanker vessel	< 15,000	257
Luckenbach Episode	Nov-Jan, 2002-2003	Sonoma-Monterey	Leaking sunken non-tanker vessel	< 35,000?	546

which are dedicated to the Alaska-to-California route. Alternatively, some tankers, after off-loading their cargo of crude oil, may reload with a refined oil product. Alternatively, they may leave empty and head to another port to pick up a different product. Finally, they may depart for a port to go into dry-dock for maintenance. The only dry dock facilities on the West Coast for large tankers are in Portland, Oregon.

When switching cargoes, tankers are often required to clean their cargo tanks of residue left over from previous cargo. This is especially true when switching from a crude oil to a refined product. When going into dry dock, the tanks must be extremely clean and free of any oil vapors. Even when not switching cargo or going into dry dock, regular tank washings are necessary to prevent the buildup of sludge in the tanks. Taken together, a vessel may do a tank washing two to three times per month. Tank washings must be done at sea, as the vapors and fumes emitted during the process violate air quality standards in the urban areas where ports are located. These tank washings may be done by spraying hot oil, hot water, or cold water into the cargo tanks in order to remove oil residues. These methods, respectively, achieve increasing levels of cleanliness. The remaining oil and water left over from a tank washing is typically stored in one or more slop tanks. Various lubrication and other oils spilled during ship operations may also be stored in the slop tanks. After some settling in a slop tank, the oil and water separate and the oil rises to the top. This allows the cleaner water under the oil to be separated and pumped into the sea. An oil-water separator gauges the amount of oil present in the water and prevents excessive oil from entering the ocean. However, it takes an experienced and conscientious crew, as well as properly functioning instruments, to prevent the discharge of oil (Griffin 1999).

In theory, the remaining "slops" are kept in the slop tanks and discharged at a reception facility at the next port of call. Slops from a tank washing are not kept beyond the next port of call, as the slop tanks are typically used to hold cargo as well. This practice is called "load on top", whereby oil cargo is loaded on top of oil slops. A large quantity of slops means less room for cargo. Note that this practice also makes it impossible for a full vessel to dump slops at sea.

Throughout much of Asia and Europe, slop tanks are inspected at each port of call and the oil is expected (or required) to be off-loaded at a facility. A lack of sufficient slops may result in prosecution and fines. In the United States, however (with the exception of Alaska), slops are almost never off-loaded at a facility (F. Whipple, pers. comm.). Moreover, slop tanks are not routinely inspected and there is little effort to account for the disposition of waste oil. Alaska is the exception, requiring tankers to off-load slops (and ballast water) in Valdez.

In order to comply with MARPOL, the United States must ensure that port facilities exist to receive such waste oil. These facilities do indeed exist in a physical sense. However, in practice, they do not receive waste oil on a regular basis (F. Whipple, pers. comm.). Both the vessels and the facilities face economic disincentives to off-loading slops. If it cannot be done simultaneously with the off-loading of cargo, the off-loading of slops may take as long as eight hours for a large vessel, which represents a significant cost of doing business. For the facility, the value of the oil may be small relative to the cost that it takes to treat it and refine it (G. Karr, pers. comm.). There are also regulatory concerns, as laws may classify any unwanted water associated with the slops as toxic waste, thus subjecting the port facility to unwanted requirements. Simply put, the port facilities do not want the waste oil.

Without sufficient incentives for port facilities to receive the slops or for the vessels to off-load the slops, and without regulatory requirements and enforcement to mandate the off-loading of slops, the shipping industry must nevertheless discharge the residues of their tank washings somewhere. And that somewhere is the sea (OSIR 2002a,b). As Deck-Officer.com, a webpage geared toward the shipping industry, states, "If the ports fail to provide the reception facilities the captain of the ship has to dispose of the wastes in some other way. The temptation is to do this illegally and hope that no one finds out."

In this context, the slop tanks and the oil-water separator gauge may be bypassed entirely, with the oily residues from the cargo tanks discharged directly into the ocean (OSIR 2002a,b). A tank washing for a large tanker may take two to three days. The first fifteen hours produce the largest amount of oily waste. Because the residual oil in the tank is approximately 0.35% of the original cargo, this may constitute, on a large tanker (e.g., 100,000 Ton Deadweight), over 3,500 liters in residual oil (Griffin 1999). Typically, a tanker may have twelve or more tanks. If all tanks are washed, as much as 40,000 liters (285 barrels) of oil may be discharged. Note that the Platform Irene, *Kure*, *Command*, and *Stuyvesant* oil spills (see Table 1) each involved less than 30,000 liters.

Tank washings typically do not occur until the vessel has been underway for 24 hours. This may put the vessel 400 to 480 km offshore if they are headed across the ocean. Tankers traveling along the coast, in accordance with a voluntary agreement with state and federal agencies, stay about 80 km offshore. Non-tank vessels may be much closer. However, when doing a tank washing, tankers may deviate to be over 150 km offshore.

CHRONIC OIL POLLUTION

In order to examine the risk that a tank washing discharge may pose to seabirds, it is necessary to consider the frequency of tank washings and to analyze the quantity of oil released over time and the distance the oil must travel to impact seabirds. Given the volume of tanker traffic in and out of California each day, it is quite possible that a tank washing occurs several times each week off the California coast. Note also that it is vessels importing foreign crude (i.e., not Alaska crude) or refined products that are most likely to conduct a tank washing. Since 1990, California's imports of foreign crude oil have increased nearly five-fold, from around 35 million barrels/year to 170 million barrels/year (California Energy Commission 2001).

If a vessel did indeed discharge 40,000 liters of oil over 15 hours, and was moving at a rate of 25 km/hour, it would have discharged the oil at a rate of 107 liters per km. The MARPOL limit is 16 liters per km. To comply with MARPOL, a vessel would have to discharge the 40,000 liters over 2,500 km, which would take over four full days. Given tight shipping schedules and the need for the crew to perform other tasks during a voyage, a vessel may not elect to spend four to five days discharging waste oil. These calculations suggest that regular tank washings can produce the equivalent of a small oil spill. Moreover, because the oil is spread over a large area from the transiting vessel, it may pose a disproportionately large threat to seabirds. The *Apex Houston* spill, which involved 97,650 liters of oil, drained from the vessel slowly as it traveled from northern to southern California, resulting in a long narrow slick that moved inshore, killing an estimated 9,900-10,500 seabirds along the Central California coast (Page *et al.* 1990, Carter *et al*. 2003). A tank washing discharge, though typically farther offshore and involving less than half the volume, mimics the dynamics of this spill.

Oil movement over the water is largely a function of wind and currents. Oil travels 100% the speed of the surface ocean current and approximately 3.5% the speed of the wind. With predominant northwesterly winds for most of the year in central California, oil discharged beyond 80 km from shore may require only a few days to move into coastal areas frequented by large numbers of seabirds, especially in the vicinity of the Farallon Islands off San Francisco where large breeding colonies exist (Sowls *et al.* 1980; Briggs *et al.* 1987; Ainley & Boekelheide 1990; Carter *et al.* 1992, 2001). Over the course of several weeks (depending on the type of oil and weather conditions), spilled oil will coagulate into tar patties and eventually become hard, as opposed to sticky or tacky. Because oil is most hazardous to birds when fresh, the first few days after a spill pose the greatest risk to birds. Thus, a far offshore discharge can reach large concentrations of nearshore seabirds, but only under certain weather conditions.

This analysis suggests that dumping of tank washings may pose an occasional, but not constant, threat to seabirds within about 60 km of the California coast. The greatest threat, however, is to far offshore (e.g., greater than 80 km out) seabird species. These would include Short-tailed Albatross *Phoebastria albatrus*, Black-footed Albatross *Phoebastria nigripes*, Leach's Storm Petrel (*Oceanodroma leucorhoa*), Ashy Storm-Petrel *Oceanodroma homochroa*, Xantus's Murrelet *Synthliboramphus hypoleucus*, and Craveri's Murrelet *Synthliboramphus craveri*. Even though these species are found in low densities across large sections of the sea, it is reasonable to hypothesize that constant dumping from tank washings could cause significant population-level effects. While albatrosses breed in Hawaii and other Pacific islands and forage in offshore waters for part of the year, the storm-petrels and Xantus's Murrelets are local California breeders and spend extensive periods of time in these waters during the breeding and non-breeding seasons and may be regularly impacted by offshore chronic oiling. The threat posed by illegal oil discharges to Xantus's Murrelet is discussed in Carter *et al.* (2000). Regional impacts to seabird populations along shipping routes also seem possible. Perhaps the strongest example of regional impacts comes from Newfoundland, Canada, located near a major trans-Atlantic shipping lane. Here, up to 90% of beachcast Thick-billed Murres *Uria lomvia* have been oiled, while total mortality from chronic oil pollution is estimated at 300,000 birds annually (Wiese 2002).

While tank washing may occur at any time of year with equal frequency, in California "mystery tarball events", "orphan spills", and oiled birds are commonly encountered in winter, rarely in summer. California faces an unfortunate combination of events each winter with regard to tank washings. Not only are seabirds more numerous offshore, storms and currents conspire to bring the oil closer to shore. Evidence from satellite images suggest illegal discharges take place primarily at night (Gade & Alpers 1999). It is likewise possible that a tanker captain may be less concerned with detection of an illegal discharge under cover of a stormy sea, and thus conduct a tank washing closer to shore than under calm conditions

The problem of chronic oil pollution in California is potentially evidenced by the number of oiled birds and tarballs recovered each year along the coast that are not associated with any known spill. Surveys of beachcast birds by volunteers with the Gulf of the Farallones National Marine Sanctuary (Beach Watch) and the Monterey Bay National Marine Sanctuary (Beach Combers) record the percentage of oiled birds found on beaches each year. On 13 selected beaches from Sonoma to San Mateo County between 1993 and 1999, 12.5% of all Common Murre carcasses (n = 1,128) were oiled (Roletto *et al.* 2000). On 10 beaches in Santa Cruz and Monterey Counties between 1997 and 2000 (Nov, Dec, Jan, and Feb only), 4.6% of all seabirds (n = 1,251) were oiled (pers. Comm. K. Newton). On beach surveys conducted statewide between 1971 and 1985, 15.1% of all Common Murre carcasses (n = 4,402) were oiled (Stenzel *et al.* 1988).

THE *COMMAND* OIL SPILL

The *Command* oil spill involved a tanker that originally had a minor accident at the port in San Francisco (Boyce & Hampton 2002). Requiring repairs, it departed San Francisco with no cargo, on its way to dry dock in Panama. Under cover of darkness, it entered the Southern Traffic Lane at around midnight. While only 15 miles off the San Mateo County coast, it began draining the previously damaged tank, discharging oil directly over the side of the vessel. Further tank washing was evidenced several days later, when U.S. military aircraft followed a sheen trail to the vessel off the Guatemala coast. This spill is thus connected to the overall chronic oil pollution problem, as it provides an example of an illegal unreported discharge. The successful prosecution of the *Command* vessel operator and owners and the recovery of natural resource damages mark the only time a tanker vessel has been caught illegally dumping oil in California.

THE ROLE OF THE *JACOB LUCKENBACH*

All of the data regarding oiled birds and mystery spills is now tempered with the discovery of oil emanating from the *Jacob Luckenbach* (Hampton *et al.* 2003). This steamship sank in the Gulf of the Farallones in 1953. The wreck has since leaked oil. In February 2002, oil from this vessel was fingerprinted and matched to most of the oiled birds and tarballs collected during the San Mateo Mystery Spill, the Point Reyes Tarball Incidents, and several other smaller events dating back to 1992. An on-going investigation may reveal this wreck to be responsible for much of the "chronic oil pollution" between Pt. Reyes and Monterey. At least five significant mystery spills have occurred in the Gulf of the Farallones since 1978, accounting for a large percentage of the oiled birds found during that period (Nur *et al.* 1997). Nevertheless, the fact that oiled birds are routinely collected from areas far to the north and south of the *Luckenbach* suggest that illegal discharges at sea may still be contributing to the problem. Additionally, not all of the tarball and feather samples collected during events attributed to the *Luckenbach* have matched that source. Some samples have been linked to foreign crude oil or various bunker oils.

DISCUSSION

Experience in California has demonstrated that relatively small oil spills may kill thousands of seabirds (Table 1). However, gaining an understanding of the risk to seabirds from illegal oil discharges is difficult. The volumes of oil are small and the discharges occur far from shore, primarily posing a threat to highly pelagic species. Detection of oil discharges from satellites offers the most promising method for monitoring spills. Because birds oiled far at sea are unlikely to be recovered (Bibby 1981; Bibby & Lloyd 1997), quantification of seabird mortality may require knowledge of at-sea densities of birds in contact with the oil.

One potential approach to monitoring seabird densities in the vicinity of unreported oil spills is rapid aerial response to satellite detections of oil, as currently used to confirm the presence of oil in Norway (Corbley 1997). Rapid response aerial wildlife surveys are regularly employed in California during major oil spills in order to quantify at-sea densities of seabirds for estimating bird mortality from several oil spills (Ford *et al.* 1987; Page *et al.* 1990; Boyce & Hampton 2002). This information is then used to estimate the number of seabirds potentially impacted by the oil spill. By linking aerial bird surveys to rapid aerial response flights triggered by satellite detections of oil, valuable information may be gathered regarding the impacts of illegal discharges to seabirds.

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