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# Chronic oiling of marine birds in California by natural petroleum seeps, shipwrecks, and other sources



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## ABSTRACT

We assessed temporal and spatial patterns of chronic oiling of seabirds in California during 2005–2010, using data on: (1) live oiled birds reported to the Oiled Wildlife Care Network (OWCN) from throughout the state, and (2) dead oiled birds found during systematic monthly beached-bird surveys in central California. A mean of 245 ( $\pm 141$  SD) live miscellaneous oiled birds (not associated with known oil spills) were reported to the OWCN per year, and 0.1 oiled dead birds  $\text{km}^{-1}$  per month were found on beach surveys in central California. Chemical fingerprinting of oiled feathers from a subset of these birds ( $n = 101$ ) indicated that 89% of samples tested were likely from natural petroleum seeps off southern and central California. There was a pronounced peak during late winter in the number of oiled birds reported in southern California, which we theorize may be related to large storm waves disturbing underwater seeps.

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## 1. Introduction

Oil pollution is a significant source of mortality for marine birds and is recognized as a global problem for marine wildlife (Burger and Fry 1993; Votier et al. 2005). Large catastrophic spills typically have relatively well-documented impacts to marine wildlife (e.g., 250,000 birds estimated killed in the *Exxon Valdez* oil spill; Piatt and Ford 1996) and garner international attention. However, chronic oil pollution (originating from natural petroleum seeps, leaking shipwrecks, vessels legally and illegally cleaning bilges in marine waters, and other non-point sources) can also be a major source of mortality for seabirds, and is more difficult to quantify.

Systematic beached bird surveys have documented a high degree of chronic oiling in some locations. For example, Wiese and Roberston (2004) estimated that 300,000 seabirds are killed annually by chronic oiling in waters surrounding Newfoundland. Substantial chronic oiling has also been documented in northern Europe (Dahlmann et al., 1994; Camphuysen 1998; Lennart Larsen et al. 2007), the southwest Atlantic (García-Borboroglu et al., 2010), and in California (Stenzel et al., 1988; Roletto et al., 2003). These studies have been based on total number or proportion of dead oiled birds recorded on beached bird surveys (Camphuysen and Heubeck, 2001; Wilhelm et al., 2009). The primary source of

chronic oiling in most cases has been presumed to be discharge of oily waste water (e.g., from tank washings) from vessels at sea (Dahlmann et al., 1994; Wiese and Roberston, 2004; Lucas and MacGregor, 2006), although subsequent to implementation of the Oil Pollution Act of 1990, oily waste discharge has been illegal in waters of the United States (Hampton et al., 2003a).

While much chronic oiling is related to anthropogenic sources, certain coastal marine areas also receive a significant amount of chronic petroleum contamination from natural seeps. Worldwide, it is estimated that 600,000 metric tons of oil are released into the marine environment annually from natural seeps, comprising approximately 50% of the crude oil entering oceans each year (Kvenolden and Cooper 2003). While presumably the degree of impacts of seep oil on marine birds is comparable to that of anthropogenic releases of petroleum, detailed assessments have not previously been conducted.

The Santa Barbara Channel, California, USA, contains some of the most productive marine oil seeps in the world, and may contribute 20,000 metric tons of crude oil to the marine environment per year (Kvenolden and Cooper, 2003). Oil here seeps from fissures in Monterey Formation sediments, weathers at sea, and often washes ashore as tar balls primarily throughout southern and central California, but can range as far north as the San Francisco Bay area (Hostettler et al., 2004; Peters et al., 2008). The oil reservoirs below the Santa Barbara Channel are also a primary target for offshore oil drilling within California.

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Beached bird monitoring projects in California in the late 1970s revealed that the percentage of dead birds that were oiled was substantially higher in the Santa Barbara Channel than elsewhere in California, with oiling proportions of >50% at some locations (Lewis et al., 1981; Stenzel et al., 1988). It was assumed that the majority of this oiling was related to the productive local seeps, especially those off Coal Oil Point in Santa Barbara. Anecdotal reports of oiled birds in the Santa Barbara Channel continued through the 1980s and 1990s, but there has been no regular monitoring of deposition rates of dead birds in the area since. In January 2005, an acute “mystery” oiling event, known as the Ventura Oiled Bird Incident (VOBI; Oiled Wildlife Care Network (OWCN)/Office of Spill Prevention and Response (OSPR), unpubl. data), occurred in the Santa Barbara Channel, rekindling interest in the potential impact of southern California seeps on wildlife. Almost 1500 birds, primarily Western/Clark’s Grebes (*Aechmophorus occidentalis/Amphiprion clarkii*; Humple et al. 2011), were oiled by natural seep oil that accumulated over time within a tributary of the Santa Clara River, 25 km inland from the coast. Heavy rains apparently resulted in this pool of seep oil washing downstream and contaminating coastal waters near the mouth of the river.

In central California, substantial chronic oiling also occurred over a period of approximately 50 years via bunker fuel leakage from a sunken cargo ship, the *S.S. Jacob Luckenbach*, off of San Francisco (Hampton et al. 2003b). It is estimated that this leakage resulted in the death of >50,000 seabirds between 1990 (when claims under the Oil Pollution Act could first be made) and 2003 (Luckenbach Trustee Council 2006). Leakage and subsequent bird impacts occurred primarily during winter months after extremely powerful ocean swells apparently flushed oil from the wreck (Hampton et al. 2003b). During the summer of 2002, the majority of the oil was removed from this wreck, greatly reducing subsequent impacts to marine wildlife (Nevis et al. 2011a).

Another leaking shipwreck, the *S.S. Palo Alto*, a ship intentionally beached in Santa Cruz County (central California) in 1929 as a recreational pier, oiled at least 69 birds (45 recovered live and 24 recovered dead on nearby beaches) between September 2004 and July 2006 (OSPR unpubl. data). In summer 2006, the last of the remnant oil was removed from tanks along with an additional 173 unidentified bird carcasses that had been trapped inside the ship.

Historic information from both shipwrecks and natural seeps indicate that weather can play a significant role in oiling of marine birds. Hampton et al. (2003b) reported that from 1996 to 2002, oiling events related to the wreck of the *Luckenbach* occurred predictably in relation to significant wave height of  $\geq 7$  m off of San Francisco. Extreme wave action also may release natural sources of oil by loosening sediments or tar blocking seep vents or by expanding sea floor fractures (Leifer and Boles 2005; Peters et al. 2008; Lorenson et al. 2011). In addition, rainfall may increase subsurface hydrostatic pressure on oil reservoirs or may flush oil from inland locations to the sea (Peters et al. 2008; Lorenson et al. 2011) as seen during the VOBI event in 2005.

Because of the disparate sources of oiling and different surveillance methods that organizations use to document oiled seabirds outside of declared spill responses, no summary of such chronic oil impacts has yet been made in California on a broad basis. Here, we investigate patterns of chronic oiling of marine birds in California from natural seeps, shipwrecks, and other sources during the period 2005–2010. First, we use records of live oiled birds reported throughout California and dead oiled birds found in central California to assess overall magnitude and annual, seasonal, and geographic patterns of chronic oiling of marine birds. Second, using chemical fingerprints of oiled feather samples, we assess potential sources of chronic oiling, and assess whether oiling from the *Luckenbach* has continued to decrease since cleanup operations in

2002. Finally, due to the dynamics associated with the VOBI and *Luckenbach* events, we assess potential effects of environmental conditions (rainfall and ocean wave energy) on the seasonal and geographic patterns of oiling.

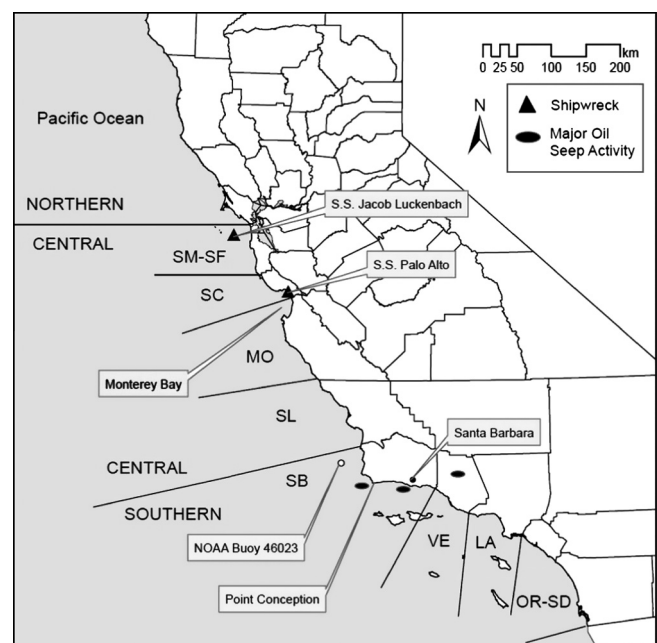
## 2. Methods

### 2.1. Statewide: live oiled birds

To assess annual, seasonal, and geographical extent of oiling of marine birds throughout California, we examined records from the Oiled Wildlife Care Network (OWCN), a California state-funded organization founded in 1994 to oversee oiled wildlife recovery and rehabilitation by using more than 30 member groups dedicated to responding to oiled wildlife. Approximately 15 OWCN member groups actively responded to reports of live coastal oiled wildlife or received live oiled wildlife from the public during 2005–2010. OWCN member groups reported to OWCN staff the date, location, and species of oiled wildlife received. We used reports for live oiled birds statewide from the six-year period from January 2005 through December 2010. We used only reports of birds collected from coastal marine locations and visibly oiled with a dark substance that was potentially petroleum (i.e., vegetable and fish oil were excluded). Typically, birds were reported with visible black oil or tar, covering from 5% to >80% of their bodies.

We compiled information on the number and species of birds reported by month and by county. We present analyses for three main regions: southern California (Santa Barbara County and south; primarily south of Point Conception), central California (San Luis Obispo County north to San Francisco County), and northern California (Marin County and north; Fig. 1).

A significant acute anthropogenic spill from the *M/V Cosco Busan* occurred during November 2007 in San Francisco Bay, oiling an estimated 5427 seabirds and waterfowl and 2841 shorebirds (Ford et al. 2009, OSPR unpubl. data). Concurrent with the *Cosco Busan* spill, an additional 757 marine birds affected by a dinoflagellate



**Fig. 1.** Map of the California coast study area, with the following County codes: SM-SF (San Mateo and San Francisco), SC (Santa Cruz), MO (Monterey), SL (San Luis Obispo), SB (Santa Barbara), VE (Ventura), LA (Los Angeles), OR-SD (Orange and San Diego). The BeachCOMBERS study area included SC, MO, and SL counties.

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