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Review

Prolonged recovery of sea otters from the *Exxon Valdez* oil spill? A re-examination of the evidence

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ABSTRACT

Sea otters (*Enhydra lutris*) suffered major mortality after the *Exxon Valdez* oil spill in Prince William Sound, Alaska, 1989. We evaluate the contention that their recovery spanned over two decades. A model based on the otter age-at-death distribution suggested a large, spill-related population sink, but this has never been found, and other model predictions failed to match empirical data. Studies focused on a previously-oiled area where otter numbers (~80) stagnated post-spill; nevertheless, post-spill abundance exceeded the most recent pre-spill count, and population trends paralleled an adjacent, unoiled–lightly-oiled area. Some investigators posited that otters suffered chronic effects by digging up buried oil residues while foraging, but an ecological risk assessment indicated that exposure levels via this pathway were well below thresholds for toxicological effects. Significant confounding factors, including killer whale predation, subsistence harvests, human disturbances, and environmental regime shifts made it impossible to judge recovery at such a small scale.

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1. Introduction

When the *Exxon Valdez* ran aground in Prince William Sound, Alaska, on March 24, 1989, it unleashed not only the largest spill of oil into American waters (at the time), but also protracted legal disputes regarding Exxon's (and its successor Exxon Mobil's) liability for damages to natural resources. Both as part of and apart from these legal disputes, studies were initiated to assess immediate damages as well as longer-term effects. Few scientists then would have imagined that their studies would still be ongoing more than 20 years after the spill.

No species affected by the *Exxon Valdez* oil spill (EVOS) attracted more public or scientific attention than the sea otter (*Enhydra lu-*

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tris). The sea otter became, in effect, the "poster species" of this spill: photos of moribund oiled otters hauled out on beaches or collected in boats appeared in many popular magazines and government reports (Batten, 1990). Rice et al. (2007, p. 450) commented that "perhaps our most persistent collective memory of the oil spill is the dead and dying sea otters." A major report summarizing the "legacy of an oil spill 20 years after *Exxon Valdez*" featured sea otters on the cover and used this species as the foremost case study (Exxon Valdez Oil Spill Trustee Council, 2009).

Two reasons for the attention on sea otters stand out: no mammal suffered greater mortality from the spill, and no affected species had greater public appeal. Whereas the value of damaged fishery stocks could be measured in terms of losses to the commercial industry, the value of lost sea otters was more elusive. One valuation was $80,000 per individual, the cost that Exxon expended per oiled otter that was successfully cleaned and rehabilitated shortly after the spill (Estes, 1991). With potentially thousands of otters dying (or not being born) as an immediate or longer-term result of the spill, the significance of this species in terms of possible legal reparations, as well as its ecological role, was enormous.

Sea otters were particularly vulnerable to oil because they rely strictly on their fur for insulation; they float on the water surface when resting, swimming, or consuming food, so were apt to encounter floating oil; they groom their fur meticulously, which provided a pathway to ingestion; they eat primarily bivalve prey, some of which became contaminated; and they spend much of their time digging for prey in nearshore sediments, where some oil residues collected. Thus, otters could suffer effects from immediate contamination of their fur or chronic effects from consuming oiled prey or digging in oiled sediments. This vulnerability was recognized at the time of the spill and set in motion a host of studies to monitor short- and long-term effects of the spill. In the first 4 years after the spill, more than 20 scientists were involved in a wide range of sea otter research, mainly in Prince William Sound (PWS), costing over $3 million (Ballachey et al., 1994). Since then many millions more dollars have been spent to ascertain whether this species has recovered from the initial effects of the spill or is suffering from continued impacts. Notably, no funds were spent on active management aimed at sea otter restoration (e.g., reduced hunting or population augmentation); however, considerable efforts were expended to clean and rehabilitate oiled otters (with disappointing results: Monnett and Rotterman, 1995) and to clean oiled shorelines where otters and their prey reside (Mearns, 1996).

Oil that leaked from the *Exxon Valdez* spread from Bligh Reef in Valdez Arm in northern PWS (Fig. 1), southward through much of

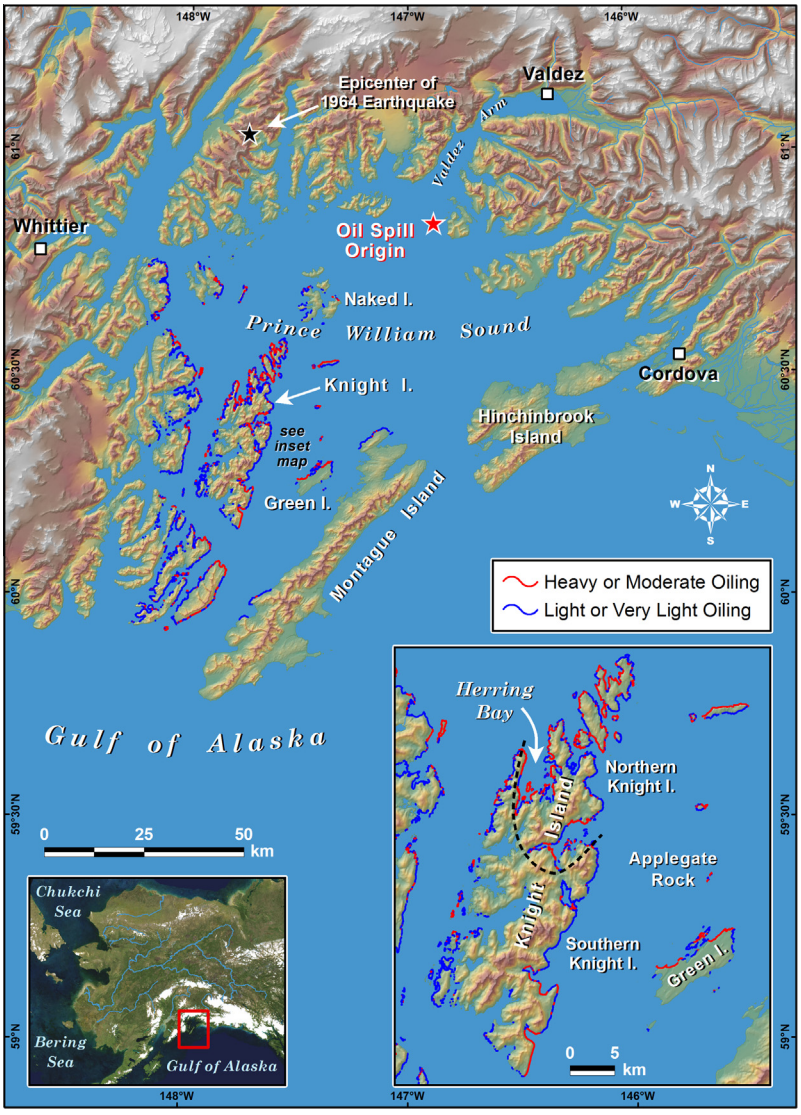

Fig. 1. Principal sea otter study sites and maximum distribution of oil on shorelines in western Prince William Sound, Alaska, following the *Exxon Valdez* oil spill.