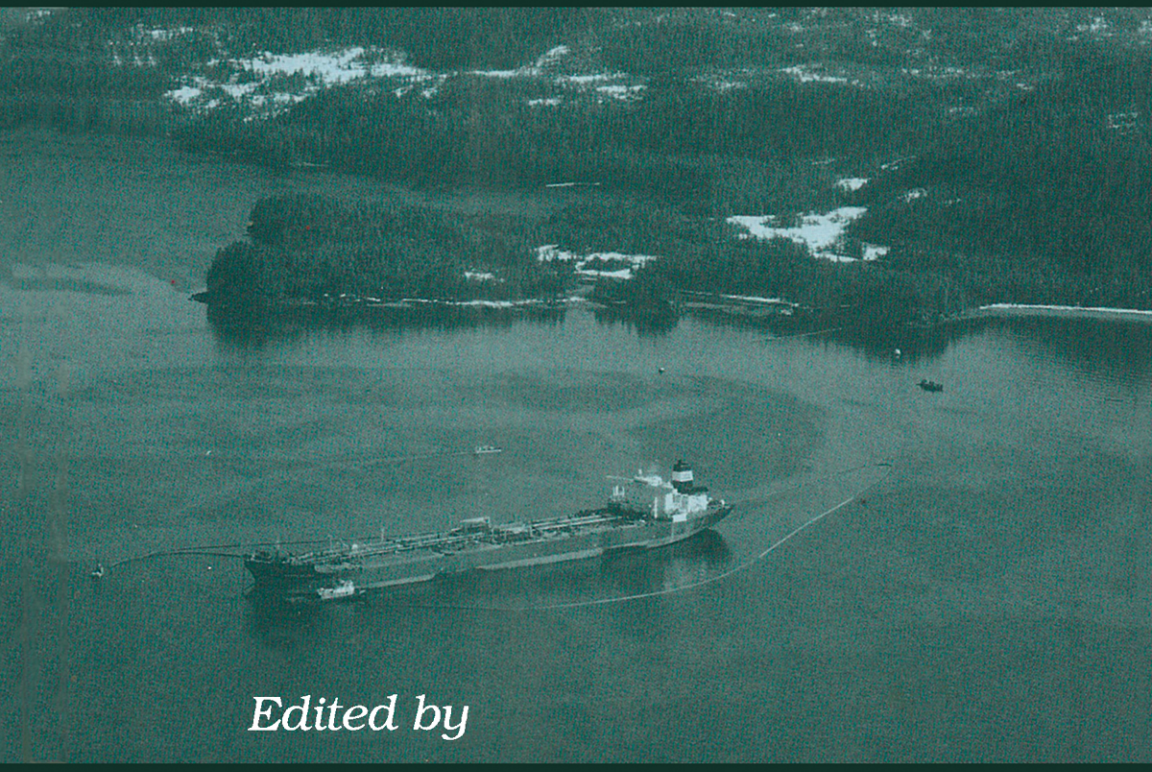
Marine Mammals and the *Exxon Valdez*



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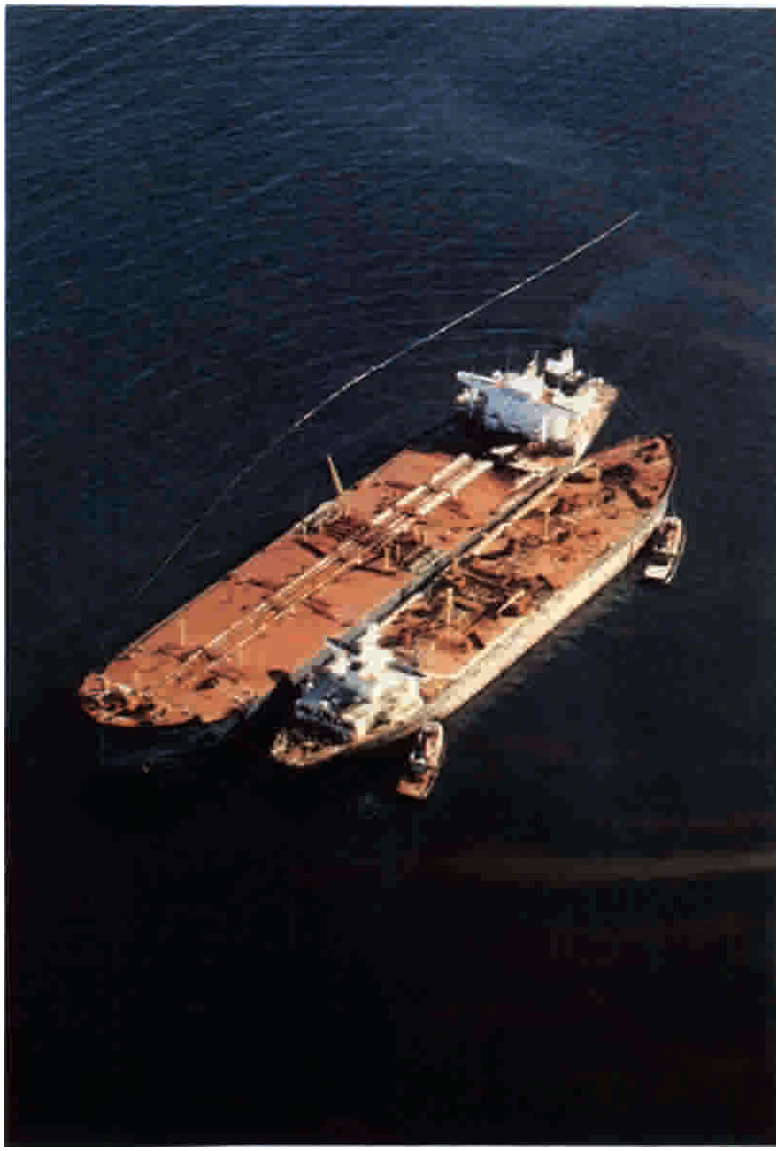

The T/V *Exxon Valdez* hard aground on Bligh Reef, Prince William Sound, Alaska. The ship hit the reef at 2404 on Good Friday, 24 March 1989, resulting in the largest oil spill in U.S. history. The photograph was taken by Dr. S. Zimmerman, National Marine Fisheries Service, Juneau, Alaska, on Easter Sunday, 26 March when the weather was calm. Later that day a storm hit causing the spilled oil to be driven southwest away from the ship and onto the shores of western Prince William Sound and into the Gulf of Alaska. The *Exxon Baton Rouge* is tied alongside to transfer the remaining oil.

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Sponsored by

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Front cover photographs: (Top) A harbor seal and its pup that were classified as "oiled" at Applegate Rocks, Prince William Sound, 8 June 1989. Note the dark coloration of the pelage behind the neck of the adult and on the flank of the pup (see Figure 12-2, by Lowry *et al*). *(Bottom)* The T/V *Exxon Valdez* at anchor near Naked Island awaiting repairs after running aground on Bligh Reef on 24 March 1989. Photograph by John Hyde, Alaska Department of Fish and Game, Juneau, Alaska.

This book is printed on acid-free paper. ♾

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Foreword

The grounding of the *Exxon Valdez* resulted in the largest oil spill in United States history. Approximately 11 million gallons of crude oil spilled from the ship and was then transported by winds and currents throughout much of western Prince William Sound and into the Gulf of Alaska and lower Cook Inlet. More than 1100 km of coastline was oiled, including parts of Chugach National Forest; Kodiak, Alaska Maritime, and Alaska Peninsula/Becharof National Wildlife Refuges; Kenai Fjords National Park; Katmai National Park and Preserve; and Aniakchak National Monument and Preserve. Detectable amounts of oil were transported to shorelines nearly 900 km from the spill site.

The contributors to this book played major roles in the design and execution of programs to assess and mitigate the impacts of the spill on marine mammals. The nature and results of those programs are described herein, including data and analyses that indicate clear and sometimes surprising impacts on some species, yet no or uncertain impacts on others. While these studies advanced our knowledge of the impacts of oil on marine mammals, much remains unknown.

For example, little was learned about the indirect effects of the spill (including containment and clean-up operations) through perturbation of the food chain. The effects of attraction to, or repulsion from, noise generated by containment and clean-up operations on species or specific age/sex classes were equivocal. The effects of contact with oil on cetaceans (particularly killer whales) could not be determined.

Except in the case of sea otters, the possible effects of the spill on long-term survival and productivity remain unknown. Even the overall biological significance of the damage caused by the oil spill in terms of the numbers of marine mammals directly or indirectly impacted was not well documented.

Even though all the related questions were not answered, the studies provided much new and important information. In fact, probably more was learned about the possible effects and ways to minimize and mitigate the effects of oil on marine mammals from the studies described in this book than from all previous studies of the effects of oil on marine mammals.

We learned that sea otters can be killed by breathing fumes from evaporating oil, as well as by heat loss when oil compromises the insulating capacity of the

animal's fur. It was shown that a single large oil spill could affect an area greater than the sea otter range in California, thus confirming that the small sea otter population in California could be jeopardized by a tanker accident. It was documented that humpback whales, gray whales, killer whales, Dall's porpoise, and harbor porpoise will not necessarily avoid swimming in spilled oil.

That so much was learned was due largely to three factors: (1) the expertise and dedication of those who planned and carried out the work; (2) the studies were initiated soon after the spill occurred and were not severely limited by funding or logistic constraints; and (3) the early establishment of an independent peer review process to help identify the most critical research needs and how those needs could best be met.

That more was not learned may be due principally to the lack of an adequate contingency plan developed and implemented prior to the event. This problem was compounded by: (1) limited information on the seasonal distribution and movement patterns, abundance, and vital rates of the affected species and populations prior to the spill; (2) constraints on communications imposed by lawyers seeking to build and to defend against claims for damages caused by the spill; and (3) reluctance or difficulty getting authority to capture or sacrifice live animals to look for evidence of exposure to and impacts from the spilled oil.

Sea otters were the most abundant marine mammal in the spill area and the species for which both immediate and long-term effects were best documented. Efforts were initiated within days of the spill to capture and rehabilitate oiled otters. Two rehabilitation centers were established and a total of 343 otters were taken to and held at those centers for cleaning and treatment. Eighteen pups were born while their mothers were being held. Of the 361 otters handled, 123 died in captivity, 196 were cleaned, treated, and eventually released back to the wild, and 37 were judged unlikely to survive if released and sent to public display facilities. Radio transmitters were surgically implanted in 45 of the adult sea otters returned to the wild. At least 12, and possibly as many as 21, of these animals died within 8 months following release, suggesting that the rescue and rehabilitation program was not very effective.

An estimated 3500–5500 otters from a total population of about 30,000 in Prince William Sound and the Gulf of Alaska may have died as a direct result of the oil spill. Oiling and ingestion of oil-contaminated shellfish may have affected reproduction and had a variety of long-term sublethal effects as well. While some population and habitat assessment studies are continuing, the duration and adequacy of these studies is uncertain.

Effects on harbor seals and Steller sea lions were even more difficult to determine because, unlike sea otters, they usually sink when dead, making accurate direct mortality estimates impossible. Furthermore, harbor seal and Steller sea lion populations in Prince William Sound and adjacent areas had been declining prior to the spill, confounding proximal versus ongoing effects.

Many harbor seals were heavily oiled, and at least 302 in Prince William Sound died after they were oiled. Heavily oiled seals behaved abnormally. They did not, for example, try to escape into the water when approached. Four types of lesions characteristic of hydrocarbon toxicity were found in the brains of heavily oiled seals. These lesions occurred principally in the thalamus and may explain the abnormal behavior.

Oil did not appear to persist on sea lions, as it did on harbor seals. Likewise, there were no indications of significant oil-caused sea lion mortality, although it could have been masked by the continuing population decline.

Five cetacean species — humpback, gray, and killer whales, and Dall's and harbor porpoises — were observed swimming in and near areas affected by the spill. However, fewer individuals were sighted than expected from prespill observation data, suggesting that many cetaceans may have left or avoided spill areas. When present in the spill area, cetaceans did not appear to behave abnormally or to obviously avoid contact with oil.

The cetacean studies provided circumstantial evidence that at least 14 killer whales may have died, directly or indirectly, as a result of the spill. One previously studied resident killer whale pod, which had 36 members in September 1988, was missing seven members when photographed on 31 March 1989. An additional six members were lost between September 1989 and June 1990; one more was lost in 1991. However, this same group of animals has been observed taking sablefish from longlines in Prince William Sound and, in 1985 and 1986, six whales were lost from the pod, possibly as a result of shooting by fishermen. Since no carcasses have been recovered there is no way to ascertain whether either shooting or the oil spill were responsible.

Aerial surveys were conducted in June 1989 to search for cetaceans that might have died due to contact with oil, and washed up on beaches. Over six thousand miles of coastline were surveyed and 37 carcasses were located. Of these, 26 were gray whales, 5 were harbor porpoises, 2 were minke whales, 1 was a fin whale, and 3 were unidentified. Only 7 animals — 3 gray whales, 3 harbor porpoises, and 1 minke whale — had not decomposed beyond use for detection of hydrocarbon contamination. Two of these animals had hydrocarbon residues in their blubber, but the levels were low and provided no evidence of impact.

This book clearly provides much new and useful information concerning the actual and potential effects of oil spills on marine mammals. However, its greatest value may be that it illustrates that damage caused by events like the *Exxon Valdez* oil spill cannot be assessed and mitigated effectively and economically without prior planning and preparation. The scientists who designed and carried out the studies described in this book no doubt learned much from the experience. Those who are responsible for planning and preparing for future oil spills should take advantage of this hard-earned expertise by asking these scientists: (1) what they view as the remaining critical uncertainties concerning the possible direct and

indirect effects of spilled oil and related containment and clean-up activities on marine mammals; and (2) what could be done to resolve these uncertainties and to be better prepared to assess, minimize, and mitigate damages to marine mammals and their habitat when oil spills occur in the future.

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Preface

When the 300-m supertanker *Exxon Valdez* grounded on Bligh Reef in Prince William Sound, Alaska, on 24 March 1989, approximately 258,000 barrels (11 million gallons) of crude oil were spilled onto the water. Federal, state, and non-government scientists were on the scene within 24 hours to determine the trajectory of the spilled oil and its possible impact on wildlife. The chapters included here represent the combined efforts of these scientists to assess the impacts of the spill on marine mammals within and adjacent to Prince William Sound.

Activity during the aftermath of the spill was divided into response and natural resource damage assessment (NRDA). The response activities included monitoring the spill, cleanup, mitigation measures (such as identifying priority areas for deployment of protection booms), and rehabilitation of oiled wildlife. The NRDA program assessed injury to wildlife from 1989 to 1992 and included studies on marine and terrestrial mammals, birds, fish and shellfish, and coastal habitat. Both response activities and NRDA studies on marine mammals are included in this book and represent multidisciplinary topics covering population biology, behavior, pathology, and toxicology.

The work presented here is unique because it was initiated as a result of an accident. Thus, many activities were guided by the needs of legal council, which did not always involve the rigors of scientific methodology [e.g., Baffin Island Oil Spill project, summarized in *Arctic* **40** (Suppl 1), 1987]. All of these studies were conducted by dedicated individuals who frequently labored under difficult circumstances but never compromised the quality of their work during this time of environmental crisis.

In some cases the marine mammal studies show a clear cause-and-effect relationship between exposure to the spilled oil and the death of some marine mammals. However, in most situations the results were equivocal and a cause-and-effect relationship could not be demonstrated.

I proposed to Academic Press that these studies be consolidated into a single volume to facilitate access of results to the scientific community and to state and federal agencies charged with the responsibility of conserving and protecting ma-

rine mammals. It is my hope that this volume will be useful to marine scientists when (not if) the next spill occurs and that our efforts to understand the effects of the *Exxon Valdez* oil spill on marine mammals will help those responding to similar events.

T. R. Loughlin

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