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Case Histories

Santa Barbara Channel Oil Spill: Spill Summary

On 28 January 1969, a Union Oil drilling platform offshore of Montecito had a blow-out. Oil was released from the well at various rates for several weeks. On February 16, Union Oil placed the first steel hood to accumulate the oil. Over 3.3 million gallons have been estimated to have been released. Nearly 1.3 million gallons had come ashore by 8 February, contaminating over 160 km of shoreline. There was a period of very heavy rainfall during the spill, with reports by divers of oily debris sinking at the fresh water/suspended sediment plume contact with salt water. Dispersants were used for over a year, with 25,080 gallons used in March 1969. Heavy oil slicks covered large areas of kelp. Straw was widely used as a sorbent.

Lessons learned

- Although large amounts of oil were held in the kelp beds for weeks, the oil did not adhere to healthy vegetation. No oil was observed in diving surveys beneath the kelp or on the bottom.
- Most of the oil was removed from the beach within months by winter storms.
- Some oil was buried on depositional sand beaches, but was removed by the following November.
- Oiled straw was much more persistent than oiled sediments.
- It was hypothesized that some oil sank when it came in contact with high loads of suspended sediments.
- Impacts to marine mammals were very small; no impacts to whales or elephant seals, but some mortality of sea lions which was not proven to be related to the spill.
- Large numbers of seabirds were affected, with little success at rehabilitation.

- Most surprisingly, very little damage was observed to intertidal organisms and no direct impacts to fish (although the commercial fishery was impacted).

References

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Kolpack, R.L. 1971. Physical, chemical,and geological studies, Volume II: Biological and oceanographical survey of the Santa Barbara Channel oil spill 1969-1970. Sea Grant Pub. No. 2. Los Angeles: Allan Hancock Foundation, Univ. S. Calif. 477 pp.

Arrow Spill, Chedabucto Bay, Nova Scotia: Spill Summary

The tanker *Arrow* ran aground on 4 February 1970, spilling about 3 million gallons of Bunker C fuel oil. Over 300 km of shoreline were contaminated. Storm waves drove the oil into the water column, both during the spill and as the oil was eroded off the beaches. This particulate oil persisted for over three months, and it was incorporated by copepods into fecal pellets. As much as 10 percent of the oil in the water column was associated with the copepods, and 7 percent was found in the fecal pellets. Extensive mechanical cleanup of gravel beaches was conducted, including removal of oiled sediments. Impacts to intertidal communities were locally severe. In sheltered areas, oiled sediments were highly persistent, and, five years later, high levels of oil were found in clams but not mussels or algae. Oiled pavements remain in sheltered areas as of 1991.

Lessons learned

- Heavy oils can be transferred to bottom sediments via uptake by copepods which then pass the oil with fecal material to the bottom.
- Natural removal of oil from high-energy shorelines occurred quickly, with only small amounts of tar remaining in sheltered microenvironments.

- In sheltered shorelines, asphalt pavements, buried oil layers, and contaminated interstitial water can persist for over twenty years.
- Removal of oiled gravel can result in increased beach and cliff erosion.
- Long-term impacts to intertidal communities are associated with persistent oiled sediments, with lower bivalve recruitment rates, lower species diversities, lower shell growth rates for clams, and dieback of brown algae still detectable six years after the spill.

References

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Exxon Valdez, Prince William Sound, Alaska

Summary

On March 24, 1989, the tanker *Exxon Valdez*, en route from Valdez, Alaska, to Los Angeles, California, grounded on Bligh Reef in Prince William Sound, Alaska. Eleven tanks were torn open in the grounding, spilling an estimated 11 million gallons of Prudhoe Bay crude oil.

Cleanup operations began almost immediately, and continued at varying levels of effort over the next two and a half years (and may not be entirely completed). In 1989, the treatments embraced a range of methods that included skimming, booming, manual pickup, wiping, and tilling, high-pressure hot-water washing, bioremediation, and tests of a number of other mechanical and chemical methods. In 1990, manual pickup, berm relocation tilling, and bioremediation were the principal methods employed. In 1991, pickup, berm relocation tilling, and bioremediation continued at a much reduced group of sites that showed evidence of significant oiling.

In July of 1990, a cooperative interagency research project was begun to evaluate the effects of oiling and treatment on the biological communities of the intertidal zone, and to study the course of recovery from both. Designed as a long-term monitoring effort, the program has continued into 1991 and beyond. Original funding sponsors of the project included NOAA, the U.S. EPA, the U.S. Coast Guard, and the American Petroleum Institute/Minerals Management Service. Exxon USA provided vessel and aircraft logistics in 1990. In 1991, the Marine Spill Response Corporation also became a sponsor, while Exxon withdrew completely. The intent was to create a long-term monitoring program to track recovery and differences in rates of recovery among sites that had received different degrees of oiling and treatment, with the ultimate goal of providing guidance as to the ecological effects of treatment methods.

Results of observations

- Significant differences were noted among sites that were a) oiled and hot water washed, b) oiled and not hot water washed, and c) unoiled. At sites where hot water washing was employed, important representatives of the intertidal community were missing or seriously depleted.
- While evidence of bioaccumulation was noted in some intertidal organisms, particularly mussels, there was no evidence of biomagnification through the food web.
- Although eelgrass studies showed adverse impacts related to oiling in 1990, by 1991 such differences were not observable.
- By 1991, most areas showed signs of recovery being well underway. However, the sites that had experienced the most severe treatments in 1989 were still obviously retarded in the extent of recovery noted. In addition, some intrusively treated sites that appeared normal from the perspective of algal cover showed a severely altered animal community structure relative to less harshly treated sites.

Lessons learned

- High pressure hot water washing can be effective in mobilizing stranded oil so that at least some can be recovered from the shoreline. However, the temperatures and pressures typically used in such operations result in a wide range of adverse biological impacts, from sterilization of the treated intertidal zone to movement of oil residues from one zone to another.

- Although negative biological impacts were observed to have resulted from both oiling and intrusive shoreline treatment, those attributable to treatment predominated. At the most severely treated locations, only minimal signs of recovery were evident in fall of 1991.
- However, at most oiled sites, the process of recovery appeared to be well underway in 1991.
- Limited evidence suggests that it may be possible to mediate the adverse impacts of washing by reducing both temperature and pressure of the water. Areas where such judgement was used show lesser degree of impact than those where 140° high pressure washing was used.
- It is very important to monitor and document as accurately as possible the extent of oiling on shorelines, and the treatments that take place. Lack of detailed information on both of these seriously hinder subsequent evaluation of recovery.
- If a monitoring program is to be established, it is very important to designate areas where no treatment is to take place. However, it may be very difficult to obtain consensus on this, particularly in highly visible, heavily utilized, or heavily populated areas.

Texaco Refinery Spill, Fidalgo Bay, Washington

Summary

During a tanker offloading operation on February 22, 1991, a shoreside booster pump failed at the Texaco March Point refinery. A large piece of the pump casing broke and was thrown 90 feet, and North Slope crude oil began pouring from the pump. The oil flowed across a field and into a drainage ditch, and ultimately oil entered Fidalgo Bay through two culverts. 210,000 gallons of oil were estimated to have spilled, with approximately 20-30,000 gallons entering Fidalgo Bay.

Fidalgo Bay is a relatively small and shallow embayment in northern Puget Sound near the city of Anacortes, Washington. It is characterized by a broad mud flat intertidal area, and large subtidal eelgrass beds. The shoreline surrounding Fidalgo Bay, although it includes fringing marsh vegetation, is not exactly a pristine environment: much of the area was diked and filled for agricultural purposes in the late 1800s and early part of this century, and presently, a state highway borders two sides of the bay.

In an effort to keep the oil from contaminating the extensive eelgrass beds and the herring spawn that was associated with it at the time of the spill, the oil that was present along the shore was effectively boomed in, preventing it from moving into the offshore eelgrass beds but holding it against portions of the shoreline and variably contaminating part of the fringing marsh. The spill took place during an unusually high tide series and oil reached portions of the shoreline only occasionally flooded.

Skimming operations took place on the water, while on the shoreline, a number of different cleanup methods were employed. Some rubble substrate that had been oiled was removed and replace with clean substrate, to minimize oil exposure to smelt that use the area for spawning. Other areas were hand wiped to remove visible oil. Heavily oiled portions of the marsh/shoreline were vacuumed using vacuum trucks. Where possible, low pressure ambient temperature seawater was used to lift oil in conjuction with vacuuming. Lightly oiled areas were raked with pom pom material. Pom pom-type booms were strung along the shoreline to capture oil that seeped or was flushed into the water.

In April, in order to evaluate the progress of recovery in the marsh, NOAA began a simple program of monitoring the chemistry and biology of the marsh area, and sampling visits have continued on a regular basis since then. The sampling program has consisted primarily of monthly photographs of a series of 0.25 m^2 quadrats established in oiled and unoiled areas, and chemistry collections of marsh sediments. Samples for analysis of below-ground biomass were collected during the initial visit and will likely be collected on an annual basis.

Results of observations

- Chemical analyses of the most heavily impacted portions of the shoreline indicated that the weathering of the North Slope crude oil began at a slow rate relative to that observed in the initial weeks of the Exxon Valdez spill. However, the rate in Fidalgo Bay accelerated significantly during the warm months of July and August.

- Marsh plants were relatively dormant until June, when noticeable growth occurred at both oiled and unoiled sites. Growth continued through September.
- Areas with heaviest amounts of oil remaining on the surface showed little or no growth of marsh plants. However, areas with moderate amounts of oil had steady growth through the growing season.
- Areas that were subjected to the most foot traffic have been among the slowest to recover.

Lessons learned

- Even simple qualitative projects can yield useful insights into how areas recover from environmental insults and how treatment can affect the process of recovery.
- Removal of spilled oil in marshes resulting in relatively low biological impacts is possible under certain circumstances that are related to the physical and biological characteristics of the marsh, the intrusiveness of the remedial technique, the season of the year, and other considerations.
- Removal of the oil has apparently speeded the recovery of those portions of the marsh where it occurred.
- Techniques to minimize the impacts of foot traffic and equipment access resulted in significantly lesser adverse effects on the recovery of the marsh.
- However, minimization of impacts required near constant vigilance and threat of financial discomfort.