Part – 3

The Exxon Valdez

Oil Spill:

Prince William Sound

Alaska, USA, 1989

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The Exxon Valdez – Alaska, March 1989

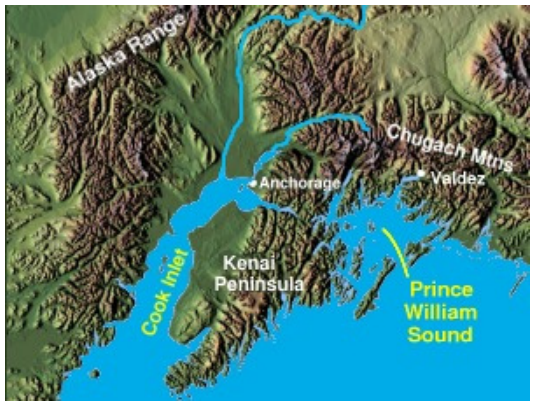
Introduction

In the global scale of oil leaks and spills the Exxon Valdez spill is a relatively small event. However, it is given much more credence than it deserves because it happened on U.S. territory and gained much more publicity than almost any other incident. It was also the longest lasting cleanup operation, partially for political reasons, partially for public relations and good citizenship reasons and finally because environmental reasons have made it one of the most residual spills. The reasons for this are explained in this article.

The Geography of Prince William Sound

Prince William Sound[i] is a deepwater sound off the Gulf of Alaska on the south coast of Alaska. It is located on the east side of the Kenai Peninsula. Its largest port is Valdez, at the southern terminus of the Trans-Alaska Pipeline. Other settlements on the sound, which contains numerous small islands, include Cordova and Whittier plus the Alaskan native villages of Chenega and Tatitlek.

Prince William Sound is ringed by the steep and glaciated Chugach Mountains. The coastline has with many islands and fjords, several of which contain tidewater glaciers. The principal barrier islands forming the sound are Montague Island, Hinchinbrook Island and Hawkins Island.



Valdez & Prince William Sound

The Oil Spill

Shortly after midnight on 24th March 24, 1989, the Exxon Valdez supertanker ran aground on Bligh Reef in Alaska's Prince William Sound. Despite the efforts undertaken to stabilize the vessel and prevent further spillage of oil, more than 250,000 barrels of oil (approximately 10.9 million gallons of its 53 million gallon cargo) were lost in just a short period of time.

The Exxon Valdez aground on Bligh Reef. (Source: NOAA)

The oil would eventually impact over 1,100 miles (1,750 km) of non-continuous coastline in Alaska.[ii] The images that the world saw on television that spring were of heavily oiled shorelines, dead and dying wildlife and thousands of workers mobilized to clean beaches. These images reflected what many people felt was a severe environmental insult to a relatively pristine, ecologically important area that was home to many species of wildlife endangered elsewhere. In the weeks and months that followed, the oil spread over a wide area in Prince William Sound and beyond, resulting in the largest oil spill cleanup ever mobilized up to that time.

On 26th March, a storm, which generated winds of over 70 mph (110 km) in Prince William Sound, weathered much of the oil, changing it into mousse and tar balls and distributed it over a large area. By 30th March, the oil extended 90 miles (150 km) from the spill site. Ultimately, the spill stretched 470 miles (750 km) southwest from Bligh Reef to the village of Chignik on the Alaska Peninsula. Approximately 1,300 miles (2,000 km) of shoreline were oiled. 200 miles (320 km) were heavily or moderately oiled (obvious impact); 1,100 miles (1,720 km) were lightly or very lightly oiled (light sheen or occasional tar balls). The spill region contains more than 9,000 miles (14,400 km) of shoreline.

The oil slick (blue areas) eventually extended 470 miles southwest from Bligh Reef. The spill area eventually totalled 11,000 square miles. (Source: Exxon Valdez Oil Spill Trustee Council).

The Environmental Damage to the Alaskan Coastline

In addition to the storm of 26th March, the spill occurred at a time of year when the spring tidal fluctuations were nearly 18 feet (5.5m). This tended to deposit the oil onto shorelines above the normal zone of wave action. The diversity in shoreline types in the affected areas led to varied oiling conditions. In some cases, oil was present on sheer rock faces making access and cleanup difficult, or on to rocky beaches with the grain size anywhere from coarse sand to boulders, where the oil could percolate to a sub-surface level. The spill affected both sheltered and exposed shorelines. Once the oil had landed on a shoreline it could be floated off at the next high tide, carried away and deposited in a different location as the tide went out. This made the tracking the oil migration and assessment of the shoreline impact very difficult. This migration ended by mid-summer 1989, and the remaining cleanup dealt with oiled shorelines, rather than oil in the water.

The real damage caused is difficult to determine as a fisherman from Kodiak Island will gain greater compensation if the damage is great, whereas an Exxon engineer, or a NOAA biologist is likely to provide such a different answer that the internet sites consulted appear to cast doubt that the same question was asked of each party. In particular, disagreements exist between Exxon and the 'independent' government-funded scientists. They do not agree on a common understanding of how multiple processes combine to drive observed dynamics.

Despite this, there are some things that are known with a high degree of certainty. For instance, the oil persisted in toxic forms for more than ten years where it had percolated into the sub-strata and it was sufficiently available to induce chronic biological exposures. The cold water prevented the speedy microbial degradation available in the warm Persian Gulf resulting in long-term impacts to the wildlife population levels. Three major pathways of long-term impacts emerged:

(1) chronic persistence of oil, biological exposures, and population impacts to species closely associated with shallow sediments;

(2) delayed population impacts of sub-lethal doses of oil compromising health, growth, and reproduction; and

(3) indirect effects of interaction cascades, all of which transmit impacts well beyond mortality.

Marine mammals and seabirds were most at risk from floating oil because they have routine contact with the sea surface. Oiling of fur or feathers causes loss of insulating capacity and can lead to death from hypothermia, smothering, drowning, and ingestion of toxic hydrocarbons. Scientists estimate mass mortalities of 1,000 to 2,800 sea otters, 300 harbor seals, and large numbers of seabird deaths estimated at 250,000 in the days immediately after the oil spill. Mass mortality also occurred among macro-algae and benthic invertebrates on oiled shores from a combination of chemical toxicity, smothering, and physical displacement from the habitat by high pressure wash-water applied after the spill. Steam-cleaning was probably more damaging to the environment than the oil itself.

Sea birds killed by the Exxon Valdez oil spill. (Source: NOAA)

The Cleanup and Recovery

On the evening of 25th March, less than 24 hours after the spill, a test in-situ burn of oil on water was conducted. Approximately 15,000 to 30,000 gallons of oil were collected using a Fire Boom towed behind two fishing vessels in a U-shaped configuration. It was then ignited. The oil burned for 75 minutes and was reduced to approximately 300 gallons of residue that could be easily collected. The test burn was 98% successful. However, further in-situ burning was not permitted by the EPA (Environmental Protection Authority) until a full assessment and analysis was completed. Unfortunately, the delay in decision making allowed the spill to thin out and spread and then further burns were not possible because of the change in the oil's state after the storm of 26th March.

Five dispersant trials took place between 25th – 28th March, but by 29th March the Regional Response Team (RRT) decided that dispersants were no longer feasible, because there was not enough equipment to protect all the shorelines that could be impacted, Federal, state and local agencies collaborated to establish shoreline protection priorities and fish hatcheries and salmon streams had the highest priority; accordingly, containment booms were deployed to protect these areas. Five fish hatcheries in Prince William Sound and two in the Gulf of Alaska were boomed.

The primary means of open water oil recovery was with skimmers. In general, most skimmers became less effective once the oil had spread, emulsified and mixed with debris.

Sorbents were used to recover oil in cases where mechanical means were less practical. The drawback to sorbents was that they generated additional solid waste. Early on in the response, storage space for recovered oil was in short supply. The oil remaining on the *Exxon Valdez* was completely offloaded by the end of the first week in April 1989. After offloading operations were completed, the tanker was towed to a location in Prince William Sound for temporary repairs. Later in the summer of 1989, the vessel was sailed to California for further repairs.

Many birds and mammals were rescued and rehabilitated. Exxon paid the costs of doing so including the relocation, replacement and rehabilitation for some of the shorebirds, seabirds and the marine and terrestrial mammals that may have suffered injury or were destroyed in the *Exxon Valdez* oil spill. The values of rehabilitating this wildlife ranged from $20,000 to $300,000 dollars per marine mammal (sea otters, whales, seal lions, seals), $125 to $500 dollars per terrestrial animal (bears, river otters, mink, deer), and $170 to $6,000 dollars for seabirds and eagles.

ExxonMobil took immediate responsibility for the spill and spent over $4.3 billion as a result of the accident, including compensatory payments, cleanup payments, settlements and fines. The company voluntarily employed and compensated more than 11,000 Alaskans and businesses within a year of the spill.

Cleanup operations were scheduled around specific activities such as seal haulout activity, seal pupping, eagle nesting, fish spawning, fishing seasons, and other significant events as much as possible.

Shoreline treatment from the Exxon Valdez spill.
(Source: Exxon Valdez Oil Spill Trustee Council)

In the above picture hoses spraying heated seawater were used to flush oil from shorelines. The released oil was then trapped by offshore boom, and removed using skimmers, vacuum trucks (useful for thick layers of oil) and boom (sorbent, snare, pompoms). For hard to reach areas, or locations with weathered oil, heated seawater was used to flush oil from the shoreline.

Converted vessels and barges were used for beach washing operations. It would take several days to outfit a conventional barge with the equipment needed to heat and pump the water. Smaller vessels that were used for beach washing early in the spill were re-outfitted for bioremediation later in the response.

Along with the large-scale beach washing, manual cleanup, raking and tilling the beaches, oily debris pickup, enhanced bioremediation and spot washing were used to cleanup the oil. In some locations, oil was thick enough to be picked up with shovels and buckets. In addition, mechanical methods were used on a few sites, including the use of bulldozers to relocate or remove the contaminated beach surfaces. Mechanical rock washing machines, which were manufactured for the spill, were not used to clean contaminated rocks and return them to the beach.

Remediation and cleaning was intensive for a year, but then continued on for another two years. Yet at Knight Island, toxicology studies in 1989 indicated that the upper and lower intertidal biota were different from pre-application communities the day after dispersant application, and returned to pre-treatment levels after only seven days.

Winter monitoring of the effects of bioremediation consisted of surveys of more than 20 beaches in Prince William Sound and the Gulf of Alaska. These studies determined that oil degradation had been enhanced on the shorelines monitored, but some debate existed over whether bioremediation was solely, or even largely, responsible.

Beach washing
(Source: Exxon Valdez Oil Spill Trustee Council)

Cleanup operations in 1989 ceased by the end of September. All parties involved in the response agreed that continuation of cleanup into the Alaskan winter would jeopardize the safety of cleanup crews. In addition, it was speculated that the winter storms in Alaska could significantly remove oil from shorelines, including sub-surface oil. By the end of the 1989 cleanup, more than 25,000 tons of oiled waste and several hundred thousand barrels of oil/liquid waste were collected and disposed of in landfills.

Cleanup began in April 1990 and ended in September. Surveys in the spring of 1990 showed that oiling conditions had been reduced or changed over the winter. Surface oil in 1990 was significantly weathered but sub-surface oil was relatively fresh in some locations. Cleanup techniques in 1990 focused more on manual methods of treatment such as hand wiping and spot washing as well as bioremediation. Mechanical equipment was used on a few sites.

Bioremediation was more extensive in 1990, with 378 of the 587 shoreline segments treated that year receiving bioremediation application. Generally, beaches were given one to three treatments over several months. By the spring of 1991, the scope of the cleanup effort was greatly reduced. Manual cleanup, bioremediation, and a very limited use of mechanical equipment were employed. Cleanup took place from May of 1991 through July of 1991.

The response to the *Exxon Valdez* involved more personnel and equipment over a longer period of time than for any other spill in U.S. history. Logistical problems in providing fuel, meals, berthing, response equipment, waste management and other resources were one of the largest challenges to response management. At the height of the response, more than 11,000 personnel, 1,400 vessels and 85 aircraft were involved in the cleanup. **In 1992 the U.S. Coast Guard declared the clean up complete**.

An important observation that resulted from the *Exxon Valdez* oil spill was that **natural cleaning processes, on both sheltered and exposed beaches, were in many cases more effective at degrading oil than the interventionist methods**. It took longer for some sections of shoreline to recover from some of the invasive cleaning methods (hot water flushing in particular) than from the oiling itself.

The prevailing wisdom was that the spill economically ruined the communities in the region. In fact, the economic loss was to ExxonMobil, but for the region there was a positive impact as tourism and fishing, both poor-paying marginal and seasonal businesses was replaced with high-paying spill-related, clean-up jobs. There was also strong business demand in other areas such as hotels, taxis, car/RV rentals and boat charters.

Long Term Effects on Prince William Sound and the Situation Today

The costs of this spill and the adverse attention it attracted from regulators and the public shook ExxonMobil management. A complete review of their operational and safety systems took place and in the years since the accident, nothing even remotely comparable has occurred. ExxonMobil has improved its spill prevention performance and the quality of its global marine transportation affiliates since the Valdez spill. In fact in 2008, there were no spills from any ExxonMobil marine affiliate owned/operated tank ships or from those on long-term lease. ExxonMobil states that this serves as a solid platform for continuous improvement of their efforts.

Twenty years after the Exxon Valdez spilled 11 million gallons of crude oil in Alaska's Prince William Sound, oil persists in the region and, in some places, "*is nearly as toxic as it was the first few weeks after the spill*," according to the council overseeing restoration efforts.

"*This Exxon Valdez oil is decreasing at a rate of 0% - 4% per year*," the Exxon Valdez Oil Spill Trustee Council stated in a report marking the 20th anniversary of the oil spill. "*At this rate, the remaining oil will take decades and possibly centuries to disappear entirely*."

The persistent nature of oil in sediments produces chronic, long-term exposure risks for some species. For example, chronic exposures for years after the spill to oil persisting in sedimentary refuges were evident from biomarkers in fish, sea otters, and sea ducks intimately associated with sediments for egg laying or foraging. These chronic exposures increased mortality rates in these species.

A healthy stand of rockweed (Fucus gardneri) growing on a boulder in Prince William Sound. (Source: NOAA)

Scientists have found that indirect interactions lengthened the recovery process on rocky shorelines for a decade or more. Dramatic initial loss of cover by the most important biogenic habitat provider, the rockweed *Fucus gardneri*, triggered a cascade of indirect impacts. After the apparent recovery of *Fucus*, previously oiled shores exhibited another mass rockweed mortality in 1994, a cyclic instability probably caused by simultaneous senility of a single-aged stand. The importance of indirect interactions in rocky shore communities and the general sequence of succession on rocky intertidal shores extending over a decade after the *Exxon Valdez* oil spill is well established.

State of Shoreline Recovery

The *Exxon Valdez* Oil Spill Trustee Council published a study in 2004 that provides an assessment of the state of the resources injured by the spill. Fifteen years after the *Exxon Valdez* oil spill, it is clear that some fish and wildlife species injured by the spill have not fully recovered. It is less clear, however, what role oil plays in the inability of some populations to bounce back. An ecosystem is dynamic and continues its natural cycles and fluctuations at the same time that it struggles with the impacts of spilled oil. As time passes, separating natural change from oil-spill impacts becomes more and more difficult.

Human uses of the Prince William Sound Environment

Human services that depend on natural resources were also injured by the spill. These services are each categorized as “recovering” until the resources they depend on are fully recovered.

Prior to the *Exxon Valdez* oil spill, there was no baseline date available for the abundant number of species existing in Prince William Sound. Because of this lack of data, numbers of oil spill-related casualties and recovery rates have been difficult for the committee to determine.

The Condition of Prince William Sound in 2010

The ecosystem in Prince William Sound today is healthy, robust and most species are again thriving. Yet controversy remains. One of the lessons learned is that a spill's impacts can last a long time in a habitat with calm, cold waters like Prince William Sound, the council said.

"*Following the oil and its impacts over the past 20 years has changed our understanding of the long-term damage from an oil spill*," the council stated. "*We know that risk assessment for future spills must consider what the total damages will be over a longer period of time, rather than only the acute damages in the days and weeks following a spill*."

"*One of the most stunning revelations*" from studies over the last decade, the council said, "*is that Exxon Valdez oil persists in the environment and, in places, is nearly as toxic as it was the first few weeks after the spill.*" As a result, some sea otter populations as well as bird species have been slow to recover. Overall, some 200,000 seabirds and 4,000 otters were thought to have died from the contamination.

Oil Found 450 miles (720 km) Away

Moreover, surveys "*have documented lingering oil also on the Kenai Peninsula and the Katmai coast, over 450 miles away*," according to the council.

None of that was expected "*at the time of the spill or even ten years later*," it added. *"In 1999, beaches in the sound appeared clean on the surface. Some subsurface oil had been reported in a few places, but it was expected to decrease over time and most importantly, to have lost its toxicity due to weathering. A few species were not recovering at the expected rate in some areas, but continuing exposure to oil was not suspected as the primary cause*."

It turns out that oil often got trapped in semi-enclosed bays for weeks, going up and down with the tide and some of it being pulled down into the sediment below the seabed.

"*The cleanup efforts and natural processes, particularly in the winter, cleaned the oil out of the top 2-3 inches, where oxygen and water can flow*," the council said, "*but did little to affect the large patches of oil farther below the surface*."

On the other hand, other scientists report that while there were severe short term impacts on many species due to the spilled oil, and they suffered damage, studies of many scientists who have worked extensively in Prince William Sound, show that there has been no long term damage caused by the spilled oil. This level of recovery conforms to the well established record of recovery documented by the scientific community following many other oil spills around the world, many of them much larger than the one that took place in 1989.

Northwest Bay Study Site[iii]

"This rocky beach on an islet in Northwest Bay is one of the OR&R study sites. Below is a photo of the site taken in June 1989, only months after the Exxon Valdez oil spill, and very soon after this area had been cleaned with high-pressure hot water. Extensive areas of dead rockweed (Fucus gardneri) are visible in this photo.

This is a photo of the same section of the site, taken in 1998. During the nine years since the oil spill, rockweed has extensively re-established itself.

ExxonMobil has contracted independent scientists to carry out in-depth studies of all pertinent aspects related to the effect of the Valdez oil spill on the Sound's water, shoreline and wildlife. To date these scientists have published approximately 400 peer-reviewed papers relating to all aspects of the Prince William Sound environment.

The truth concerning how much damage was actually done and state of the environmental recovery probably lies somewhere in the middle of the opposing sides opinions. Certainly the Exxon Valdez Oil Spill Trustee Council only continues to exist while a problem remains, while the independent scientists contracted by ExxonMobil and the government have a tendency to be more cautiously optimistic as detected improvements are likely to lead to more consultancies. Scientists continue to study the affected shorelines to understand how an ecosystem like Prince William Sound responds to, and recovers from, an incident like the Exxon Valdez oil spill.

Prince William Sound in 2006[iv]

The conclusions are obvious if we compare the effects of the much larger spill in the Persian Gulf to the results of the Exxon Valdez spill. The Gulf had warm water (25^{o}C), high salinity (read chemical content), high UV exposure, constant weather (read 'non-disruptive) – and limited human intervention offshore. The Valdez had none of these positive elements plus the use of steam cleaning and toxic dispersants which may have caused more harm than good. The data is there, but even among scientists objectivity has been less than perfect as their personal biases appear to have swayed their views and judgments.

Endnotes to Part-3

[i] http://en.wikipedia.org/wiki/Prince_William_Sound Geography extracted and adapted from this url

[ii] http://www.eoearth.org/article/exxon_valdez_oil_spill This is the main (but not the only) reference site providing details of the spill.

[iii] This site shows the devastation caused by 'remediation' and hot water cleaning. However, the Mearns Rock site shows a complicating factor as all the weed on the rock is approximately the same age and is therefore subject to a catastrophic dying off at the same time, leaving the rock periodically bare once more.
http://response.restoration.noaa.gov/topic_subtopic_entry.php?RECORD_KEY%28entry_subtopic_topic%29=entry_id,subtopic_id,topic_id&entry_id(entry_subtopic_topic)=259&subtopic_id(entry_subtopic_topic)=13&topic_id(entry_subtopic_topic)=1

[iv] http://www.google.com.au/imgres?imgurl=http://media-cdn.tripadvisor.com/media/photo-s/00/18/85/02/prince-william-sound.jpg&imgrefurl=http://www.tripadvisor.com/LocationPhotos-g60880-w2-Anchorage_Alaska.html&h=366&w=550&sz=31&tbnid=3erNHKPWbSLfAM:&tbnh=89&tbnw=133&prev=/images%3Fq%3Dprince%2Bwilliam%2Bsound&hl=en-GB&usg=__GXsxHrZcLdwhKGv5ng5GOZm4mp8=&sa=X&ei=7nYPTNj2LtGccYrVwNkM&ved=0CDoQ9QEwBQ