Exxon Valdez Oil Spill
Restoration Project Annual Report

Chenega Shoreline Restoration - Monitoring

Restoration Project 96291-2
Annual Report

This annual report has been prepared for peer review as part of the *Exxon Valdez* Oil Spill Trustee Council restoration program for the purpose of assessing project progress. Peer review comments have not been addressed in this annual report.

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Study History: Residents of Chenega Bay, in western Prince William Sound, have long been requesting that the Trustees support additional efforts to remove *Exxon Valdez* oil from several beaches in their area. The project took place in the summer of 1998, over 30 days from mid-June through mid-July. The techniques used involved disruption of the asphalted oil with air knives, that inject pressurized air into the sediments. Small quantities of the proprietary surfactant PES-51 were injected as well to loosen oil from rocks and to make it easier to collect. The work area was flooded with ambient temperature sea water to sweep released oil into catchment booms in the tide water below. Details are provided in the annual report of Chenega Shoreline Restoration (Restoration Project 97291) by Dianne Munson and Ginny Fay of the Alaska Department of Environmental Conservation, the agency responsible for overseeing the labor contract, and Dan Easton and Jason Ginter of Easton Environmental. There was considerable skepticism among some agencies whose permits were required for the project to go forward as to whether the proposed methods would be sufficiently successful while causing little enough harm to be worthwhile. Therefore the Trustees requested that the associated small scale hydrocarbon monitoring planned by the NMFS Auke Bay Fisheries Laboratory be considerably expanded and biological monitoring included as well. This portion of the project is called Chenega Shoreline Restoration - Monitoring.

Abstract: In June and July of 1997, at the request of residents of Chenega Bay, *Exxon Valdez* crude oil was removed from 10,000 m^2 of beach on the north end of Latouche Island (mostly in Sleepy Bay) and on the northeast corner of Evans Island. We undertook an extensive beach sampling process to determine how thoroughly the cleanup removed oil, and to assess any major damage to intertidal organisms or contamination of the surrounding water. Our assessments involve comparing samples and photographs taken in May of 1997, before the cleanup, with samples and photos that will be taken in May of 1998, a year later, along with intermediate samples taken in the summer of 1997 after cleaning work was completed. Preliminary conclusions based on data collected so far indicate that the cleanup probably succeeded in removing the target 50% of oil in the work areas, an probably did little serious or lasting biological damage.

Key Words: Beach Restoration, Chenega, *Exxon Valdez*, Oil Removal, Prince William Sound, Residual Oil, Shoreline Treatment, Sleepy Bay.

Project Data: (will be addressed in the final report)

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Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Auke Bay Fisheries Laboratory, Juneau, Alaska.

Executive Summary

A month-long project to remove remaining Exxon Valdez oil from beaches in the vicinity of Chenega Bay, in eastern Prince William Sound, took place in the summer of 1997, under the oversight of the Alaska Department of Environmental Conservation, as Restoration Project 97291. In conjunction, the NMFS Auke Bay Fisheries Laboratory undertook an extensive study to determine objectively whether the goal of removing at least 50% of the oil in the cleaned area was met and whether this was done without serious damage to intertidal life or contamination of the tidewater with either petroleum hydrocarbons or the surfactant used in the cleaning. This project is still underway, with the final sampling trip taking place in May of 1998, so conclusions at this point are preliminary. However, it appears that the innovative oil sampling methods required for this study are being successful, that the cleanup probably did succeed in removing more than 50% of the oil in the sampled areas, that there was no serious or long lasting damage to intertidal invertebrates and that the surrounding tidewater was not contaminated.

Introduction

Sleepy Bay, on the north end of Latouche Island in western Prince William Sound, and many surrounding beaches, were heavily oiled during the *Exxon Valdez* oil spill. Sleepy Bay opens directly into the spill path, and has no protection from open water in that direction. Considerable effort was spent in the first years after the spill to remove oil from Sleepy Bay, including a test of the efficiency of using air knives (that inject air into the sediment, breaking up oil within it) along with use of the proprietary surfactant PES-51 to loosen oil from rocks and to aid in its retrievability. Although the heavy oiling in Sleepy Bay was much reduced, a great deal of oil was left behind there (on beach segments LA016 through LA020-C) and on several nearby beaches (including LA015-C, and EV037-A and EV039-A on Evans Island). These beaches are within the area regularly used by residents of Chenega, who objected to the remaining oil, especially since they had used these beaches for hunting, fishing and food gathering and had no confidence in the safety of foods collected near the stranded oil. They have been urging the Trustees to fund additional oil removal from this area for several years.

A month-long project to remove oil from the beach segments listed above was arranged for the summer of 1998. This work, Restoration Project 97291, is described in detail in the annual report written by the Alaska Department of Environmental Conservation, the agency that oversaw the contracting process (Munson et al., 1997). The methods used included air knife injection of air and PES-51, washing the beach with ambient temperature seawater, and collection of removed oil behind floating booms. Several state and federal agencies that were required to permit different aspects of the process were skeptical whether the proposed process

would work effectively enough while doing little enough environmental damage to be worthwhile. Consequently the Trustees chose to greatly increase the associated small scale hydrocarbon monitoring planned by the NMFS Auke Bay Fisheries Laboratory to include a thorough estimation of the amounts of oil removed, a study of whether there was widespread damage to intertidal biota, and several additional measures of where oil and the surfactant might be released.

Most of our conclusions will come from comparing measurements made in May of 1997 (before the cleaning work began) to those made in May of 1998, therefore little data and no statistical analysis are presented here. However, comparison of initial measurements and observations with those made in the summer of 1997, just after the cleaning work was completed, provide some useful results and preliminary conclusions.

Objectives

Objective 1: Determine whether air knife treatment using PES-51 removes a significant amount of oil from test areas.

Objective 2: Determine whether air knife treatment without PES-51 removes a significant amount of oil from test areas.

Objective 3. Determine the severity and persistence of receiving water contamination by oil/PES-51 mixtures following beach treatment.

Objective 4: Evaluate whether lower-intertidal sediments become contaminated by oil/PES-51 mixtures following beach treatment.

Objective 5. Estimate the accumulation and persistence of oil/PES-51 mixtures liberated by beach treatment in intertidal mussels and chitons.

Objective 6. Estimate population changes of selected intertidal fauna following beach treatment.

Methods

Nearly all of the objectives require repeated visits to the work area, before the work began (May 1997), just after the work was completed (July 1997) and a year after the initial visit (May 1998). Additional sampling was done in September of 1997. At this time the last of these visits has not been completed.

Techniques used for **Objective 1** (degree of oil removal) required considerable innovation. The oil in these beaches is patchy and variable. Most is on or in the substrate between and below

large cobbles and boulders. Nearly all is covered with asphalt, some with a thick layer and some with an extremely thin one. Beneath the asphalt most of the oil is thick brown mousse that smells surprisingly fresh after eight years of weathering. It ranges from dry through gooey to liquid. The very irregular distribution of the oil makes the usual methods of determining the quantities of hydrocarbons in a small volume of substrate unfeasible. The combination of irregular distribution among large rocks and the fact that the exact areas of beach that would be cleaned could not be determined ahead of time also made it virtually impossible to sample in such a way as to learn the total amount of oil originally in the cleanup area. For these reasons we selected specific sample sites throughout the area, each to be sampled three times, before cleaning (May 1997), just after cleaning (July 1997) and again in May of 1998. Fifty-four sample sites were in areas subsequently cleaned. Three were above the reef in the middle of LA020-C, an area that could not be reached by the cleaning equipment, and an additional 6 were on LA017, a similarly oiled beach not within the area cleaned, making a total of 9 control (uncleaned) sample sites. Each sample site contained enough contiguous (or close to contiguous) surface oil for three 25 x 25 cm quadrats to be located within them, with all three covering roughly the same amount of oil. All three were surveyed and photographed so that the quadrats could be removed and replaced for the later samplings. Sampling the quadrats consisted of collecting all dirt and oil directly below the quadrat, straight down as far as one could dig before being stopped by bedrock or boulders too large to move. The collected material was extracted with solvents, which were evaporated off, so that the mass of the oil could be found and presented as kg of oil per m^2 of beach. The data for 1997 samples is now available.

Sampling for **Objective 2** (effectiveness of air knives without surfactant) used five sample sites on one small beach (the eastern end of EV039-A) that were exactly like the ones used elsewhere for Objective 1. They were sampled once in May of 1997. They were boomed off separately from sites on nearby beaches and cleaned using air knives without surfactant, then sampled. The work crew then returned and cleaned the area in the usual way, and the sites were sampled again. All the data for these five sites is available now.

Sampling for **Objective 3** (receiving water contamination) was handled by mooring local mussels (*Mytilus trossulus*) in six cages just outside the oil collecting booms below the beach work areas. Four were within Sleepy Bay (one off of LA020-B, two off of LA020-C, and one off of LA017, an uncleaned control beach) and two outside the bay, one to the east (off of LA015-C) and one to the west (off of LA020-D, another control beach). They were placed so they did not hit bottom at low tides and always remained at least three m below the surface so the cages were not contaminated by material floating on the water surface even during significant wave action. These mussels were moored in May of 1997, sampled in late June of 1997 just before beach work began, sampled in late July after beach work was completed, and again in September of 1997 when the mussel cages were brought in for the winter. The mussel cages were scheduled to be restocked and redeployed in 1998 if the mussels were contaminated when sampled in September. Tissues of sampled mussels were analyzed for the presence of petroleum hydrocarbons and d-limonene (the chief component of the PES-51 surfactant) by

GC/MS. All the data for the 1997 mussels is available now. In addition, an estimate of possible water surface contamination will be found with GC/MS analysis of six oil absorbent pads floated on the water surface at the same sites as the mussel cages, from early June to late July. These pads have not yet been analyzed.

Sampling for **Objective 4** (contamination of lower-intertidal sediments) was done by taking 30 sediment samples from the MLLW line on beach segments LA020-B and LA020-C. At this level there is enough relatively fine sediment, gravel less than 5 mm in diameter, to collect. Each sample was compiled from a fixed and marked hundred m of beach, using hydrocarbon-clean equipment and glass sample jars, for GC/FID analysis of petroleum hydrocarbons and d-limonene. Fifteen samples were taken in May 1997, before the cleanup work, and 15 in July 1997, after the work. Additional sampling is scheduled for 1998. The data for the 1997 samples is now available.

Sampling for **Objective 5** (contamination of intertidal mussels and chitons) consisted of collecting the animals into hydrocarbon-clean jars for GC/MS analysis of their petroleum hydrocarbon and d-limonene content. Mussels, which greatly concentrate materials in the water they siphon, were collected at six biological testing sites on northern Latouche Island. Four sites (LA015-A, LA020-B, and the northern and southern haves of LA020-C) were part of the cleaning operation; two sites (LA017-A and LQ020-D) were control sites. Each of these samples was pooled from along a 500 m stretch of each site, except for LA015-A which was much shorter. Samples were taken in May and July 1997. Additional unpooled samples were taken from specific spots on the Evans Island beaches (EV037-A and EV039-A) at both times. Chitons, which are collected for food in this area, were taken from large rocks below most of the same beaches, wherever they were available. A few additional mussel samples were taken in September 1997, and all samples are scheduled to be repeated in 1998. The data for the 1997 samples is now available.

Measurements for **Objective 6** (estimating intertidal population changes) were made by laying out transects from the grass line to MLLW on the five 250 m stretches of Latouche Island beaches (three cleaned and two control beaches) listed for collecting mussels. (LA015-A, short and covered with very large boulders, was omitted). Each site included six transects, each 50 m apart. Four 25 cm by 25 cm quadrats were randomly placed along each transect. The mussels, limpets, whelks, and littorine snails were counted in each quadrat, and the percent cover of *Fucus* and of all algae combined was estimated for each quadrat. These species include all that were encountered in the quadrats more than very incidentally, except barnacles. Each quadrat was located precisely enough by measurements and photographs that all subsequent counts could be made at exactly the same locations. In addition, the large mobile echinoderms (sea stars and very rarely sea urchins and sand dollars) were counted between each adjoining pair of transects, from the MLLW line up into the mussel zone. These counts were each made by three separate observers to avoid some of the subjectivity inherent in counting animals in a large area of cobbles and boulders which include a great deal of algal cover. The 1997 counts for this objective are available.

Results

Most of the objectives require the final (May 1998) samples for complete analysis, so results available so far are limited and must be considered preliminary.

Objective 1 (degree of oil removal): The clearest observations from the 1997 oil sampling data are that there was a lot of oil on these beaches, a lot was removed by the cleaning, and a lot remains. The May measurements from our selected sample sites range from 0.5 to 12.6 kg oil/m^2, and the July measurements range from 0.02 to 5.5 kg oil/m^2. Reductions seen between May (before cleaning) samples and their associated July (after cleaning) samples range from 90% to none at all, with the mean a reduction of roughly one half.

Objective 2 (effectiveness of air knives without surfactant): The beach used for this test was chosen for logistical reasons. Unfortunately, the oil patches here were shallower and drier than at many of the sample sites. This would tend to make injecting air and deluging with water more likely to break up and remove the oil with or without the addition of surfactant than might be the case where oil was wetter and stickier. This appears to have occurred. The five samples taken after cleaning with the surfactant averaged no less oil content than those taken after cleaning without surfactant. Despite the lack of measured differences in oil removed from the sample sediment, during the test more oil was observed floating on the wash water during the cleaning with surfactant than without, suggesting that the PES-51 may have made removed oil easier to retrieve.

Objective 3 (receiving water contamination): One of the cages set out in May (the one off of LA020-B) was lost to wave or tidal action before being sampled on June 17. It was replaced at that time. Mussels from all the other cages contained no detectable petroleum hydrocarbons or d-limonene at that time. Two other cages (the ones off of LA020-D and the southern end of LA020-C) were lost before the post-cleaning sampling on July 21. Of the surviving four cages, the mussels in only one (the one off of LA015-C) contained traces of detectable oil (0.1 μg aromatic hydrocarbons / g dry tissue wt). When all four were sampled again on September 16, none of the mussels contained either detectable petroleum hydrocarbons or d-limonene. Consequently, the mussel cages will not be redeployed in 1998.

Objective 4 (contamination of lower-intertidal sediments): Interestingly, the sediments from the MLLW line of the Sleepy Bay beaches contained low levels of oil both before and after the cleaning process. Further analysis of some of these samples by GC/MS will done to determine if the oil is indeed from the EVOS. Moreover, further samples will be taken in May of 1998 both from the same sites and from below the uncleaned but oily control beach LA017 and the virtually unoiled control beach LA020-D.

Objective 5 (contamination of intertidal mussels and chitons): None of the chiton samples collected contained detectable oil or d-limonene either before or after the beach cleaning.

Filter-feeding mussels are prone to concentrate chemicals from the water around them, and some of the mussels taken from the beaches just below, or in a few cases within, the areas cleaned did register low levels of both petroleum hydrocarbons and d-limonene. All the mussel samples were taken within a single week while the cleaning operations took 30 days, so the amount of time passing between cleaning and sampling varied from site to site, and the passage of time was roughly reflected by the results of tissue analysis. Mussels from LA020-B, sampled 23 days after cleanup of that beach, registered no detectable petroleum hydrocarbons or d-limonene. Mussels from LA015-C, an especially oily and difficult to clean beach sampled only 7 days after cleanup, yielded 6.4 μg aromatic hydrocarbons / g dry tissue wt and 44.2 μg d-limonene / g dry tissue wt.

Objective 6 (estimating intertidal population changes): Unusual numbers of dead or injured invertebrates were not observed during the fixed quadrat counts, the echinoderm counts, or in photographs of the beaches after the cleaning. There were a few small but significant changes in the counts of some species (numbers of Dermasterias increased after the cleaning in the control sites but not in the treated sites for instance) but nothing that could not be attributed as easily to natural causes (the oily, cleaned beaches face northeast and the early morning sun for instance, while the control beaches face northwest and morning shade) as to any effects of the cleaning process.

Discussion

Although final conclusions from this study must await the May 1998 data and statistical analysis, it is clear that our methods are producing useful information. We have found that our innovative techniques for measuring the mass of oil in selected sites does work. Many changes in the condition of the cleaned beaches may have occurred over the winter of 1997-98. Cleaned areas may well look better, as oil removed from the gravel and stranded in patches and "bath tub rings" on boulders has probably been washed clean by wave action. Asphalted oil that was disrupted but not removed from the beaches may well have been washed out. Conversely, oil more deeply buried or under boulders, beyond the reach of the cleaning process, may have moved out to replace oil that was removed. The 1998 data are needed to show how successful oil removal actually was. The 1998 invertebrate count data is especially important, since comparing May and July data from 1997 has season as a confounding factor, and since intertidal invertebrates are rugged and tend not to show damage immediately. However, it must be remembered that any population count data including only a single "before" count can only demonstrate really major damage. Nothing subtle will show through the natural variability.

The mussel tissue data taken to date do make it clear that little oil or surfactant escaped from the boomed cleaning areas. Mussels suspended outside the booms did not collect them in their tissues. Beach mussels living within or just below the cleaning took up small quantities of oil hydrocarbons and d-limonene, but mussels sampled more than 23 days after cleaning did not show detectable levels, apparently having depurated any they had concentrated earlier.

Conclusions

Despite the necessity of analyzing the 1998 data for any degree of certainty, at this time it appears that the 1997 oil removal project probably succeeded in reaching the objective of removing at least 50% of the oil present, and probably did so without causing serious or lasting biological damage.

Acknowledgments

Jeff Short designed the oil sampling process used; Larry Holland, Mark Carls, Patricia Harris, Robert Bradshaw, Bryan March, and Dave Scepp (all of the Auke Bay Fisheries Laboratory) accomplished the complicated beach work required for this project, designing many aspects of it in the process, and Dianne Munson (Alaska Department of Environmental Conservation) made this portion of Project 97291 possible by providing the necessary local knowledge and coordination with the cleaning operations.

Literature Cited

Munson, D., G. Fay, D. Easton, and J. Ginter. 1997. Chenega Shoreline Cleanup, *Exxon Valdez* Oil Spill restoration Project Final Report (Restoration Project 97291), Alaska Department of Environmental Conservation, Juneau, Alaska.