# EXXON VALDEZ Oil Spill

## NOAA's Response

March 24-September 20, 1989



Hazardous Materials Response Branch
Ocean Assessments Division
Office of Oceanography and Marine Assessment
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# Preface

NOAA's major responsibility during oil spills is to assist the Federal On-Scene Coordinator (FOSC) in understanding all sides of always complex scientific issues that may affect the course of containment and cleanup operations. NOAA acts as a liaison between the scientific community and the FOSC during spill responses, distilling technical opinions into concise recommendations upon which the FOSC can make informed decisions. NOAA draws on over a dozen years of experience in oil spill response using its expertise in physical oceanography and meteorology, oil weathering and dispersion in marine waters, assessment of the sensitivity of coastal environments, and information management.

The first questions raised after a large spill generally concern the spill's movement in the water and priorities for the protection of natural resources. NOAA draws on the abilities and knowledge of diverse agencies and experts to identify problem areas, research ideas, resolve issues, and ensure that cleanup proceeds as rapidly as is effective and environmentally beneficial.

# Introduction

Shortly after midnight on March 24, 1989, the tanker EXXON VALDEZ, en route from Valdez, Alaska to Los Angeles, ran aground on Bligh Reef in Prince William Sound. The vessel struck the reef while maneuvering to avoid icebergs in the outbound traffic lane, tearing open eleven tanks on her center and starboard side, and emptied approximately 11 million gallons of Prudhoe Bay crude oil into Prince William Sound. At 0600 the U.S. Coast Guard Marine Safety Office in Anchorage asked NOAA to calculate the probable path of the spilled oil in the Sound and to identify environmental resources at risk from the spill. By the evening of March 24, a NOAA helicopter and six members of NOAA's hazardous materials response team were on-scene at the Coast Guard's spill response headquarters in Valdez.

Over the course of the next six months, some 30 NOAA spill response specialists located in Valdez, Seward, Homer, Kodiak, and Anchorage, synthesized the technical advice from the scientific community for the FOSC responsible for overseeing EXXON VALDEZ cleanup operations. Additional support was provided by NOAA's Office of Aircraft Operations in Miami; NOAA helicopters were in Valdez for the entire six months of the spill response until operations ceased for the winter. Further NOAA support was provided by National Marine Fisheries Service (NMFS) offices in Seattle, Juneau, Kodiak, and Cordova, and by National Weather Service offices in Anchorage, Kodiak, and Valdez. NOAA also acted as a clearinghouse for reports of stranded marine mammals, and distributed notices to mariners and aircraft warning them to avoid bird rookeries and seal pupping areas. The NOAA ship RAINIER surveyed the vicinity of Knight Island to assist the U.S.S. JUNEAU, used by Exxon as a berthing vessel for cleanup workers, in locating satisfactory moorage locations.

# Introduction, *cont.*

NOAA maintained a nationwide electronic communications network, activated the morning of the incident, that served both as a library of nearly 325 detailed daily reports and as a means to keep NOAA headquarters and other agencies apprised of daily spill response activities and concerns. It also prepared special briefings for senior Federal government officials, including several congressional committees and individual members of Congress, including Senators Stevens and Murkowski and Representative Young from Alaska; Secretary of Transportation Skinner; Under Secretary of Commerce for Oceans and Atmosphere and NOAA Administrator Evans; Coast Guard Commandant Yost; Coast Guard Admirals Robbins, Kime, and Ciancaglini; and the news media.

# Daily Operations

## Overflights And Mapping

Beginning on the first day of the spill, NOAA collected information to estimate the spill's trajectory and potential environmental impact. Tide, current, and wind data obtained from NOAA National Weather Service offices in Valdez and Anchorage were entered into NOAA's mathematical oil trajectory model. These data were supplemented with overflight observations by NOAA, the U.S. Coast Guard, Exxon, and ADEC, begun the second day of the spill and continued daily, weather permitting (Figure 1).

Overflights were undertaken to track the movement of oil in the Sound; these visual observations were correlated both with NOAA's microcomputer-based hydrodynamic spill model and with remote-sensing imagery such as the Coast Guard's Side-Looking Airborne Radar (SLAR), installed onboard Falcon jet aircraft. NOAA analyzed and interpreted the SLAR overflight imagery for the FOSC at daily operations meetings, and flew joint flights

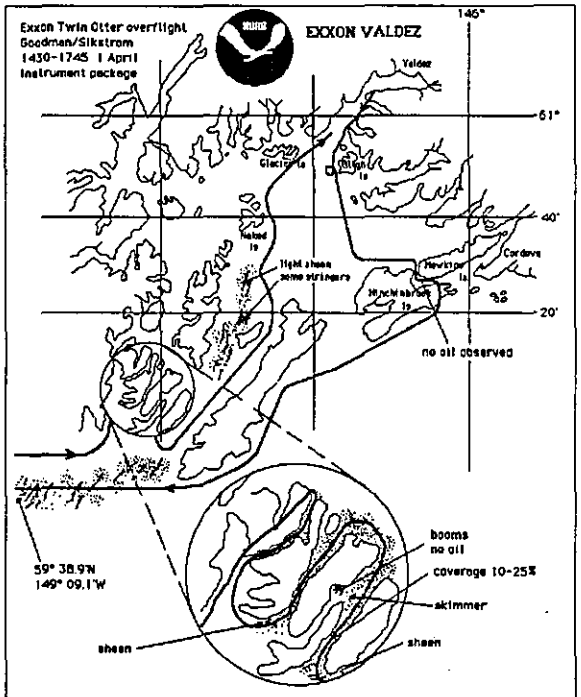



Figure 1. Sample overflight map routinely prepared and distributed to resource agencies.

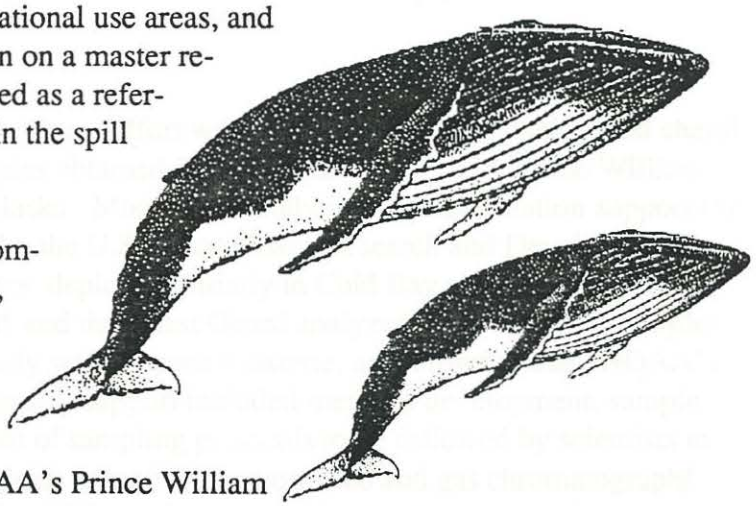
## Overflights And Mapping, *cont.*

with Exxon, ADEC, and the Coast Guard to intercalibrate the observations of these agencies as closely as possible. Maps of the oil slicks as seen from helicopter and fixed-wing overflights were transferred electronically, by facsimile machine, or hand-delivered daily to over 100 interested parties across the United States, including Federal and state agencies, Exxon, private concerns, and the press.

After each overflight, observers were debriefed by an information specialist who transferred the observer's notes onto the appropriate computerized base map. Aircraft flight tracks added to each map indicated the coverage for each flight; considerable effort was expended to standardize the translation from observer's notes to mapped data. By the end of the summer, some 260 overflight maps of the location and general concentration of floating oil had been drawn and distributed.

## Sensitive Resource Identification and Ranking

Through discussions with resource agencies and literature reviews, NOAA identified sensitive resources in Prince William Sound, including wildlife habitat, subsistence areas, and recreational use areas, and recorded this information on a master resources map that was used as a reference by all participants in the spill response.



Based on information compiled on the master map, NOAA helped draft an interagency document that identified those resources requiring priority protection. NOAA's Prince William Sound Environmental Sensitivity Atlas, published in 1983, and seasonal Environmentally Sensitive Area summaries for Prince William Sound, published in 1988, were used extensively by many agencies as reference sources for identifying marine resources at risk from the spill. The atlas and seasonal maps were integral to the shoreline committee's task of prioritizing areas for cleanup and in initial planning of secondary lines of defense should primary containment efforts fail. NOAA distributed several hundred sets of the seasonal maps to interested agencies and individuals.

## Other Information Products

Throughout the course of the spring and summer, NOAA provided the Valdez spill response community with several information products, including:

- a climatological atlas for May and June for Prince William Sound, excerpted from the *Climatic Atlas of the Outer Continental Shelf Waters and Coastal Regions of Alaska, Volume 1: Gulf of Alaska*;
- a detailed, wall-sized master map of Prince William Sound indicating the distribution and location of sensitive resources;
- a rookery notice showing locations of harbor seal, seabird, and sea lion rookeries; and
- composite flight track maps showing oil-impacted area coverage over several days.

Special weather forecasts and daily updates for morning and evening FOSC briefings were provided by the national Weather Service Forecast Office in Valdez. Weather information was distributed twice a day to all response agencies. NOAA also prepared and distributed regional tidal forecast data.

## Oil Analysis

A major concern of the response effort was characterizing the physical and chemical properties of oil samples obtained from various locations in Prince William Sound and the Gulf of Alaska. Most of the analytical instrumentation support for this effort was provided by the U.S. Coast Guard Research and Development Center's mobile laboratory, deployed initially in Cold Bay, Alaska, then transported to Valdez. NOAA and the Coast Guard analyzed more than 800 samples of oily debris, tar balls, oily water, beach substrate, and animal tissue. NOAA's extensive analytical chemistry support included methods development, sample analysis, and development of sampling protocols to be followed by scientists in the field. Analytical methods combined fluorescence and gas chromatograph/mass spectrometry to fingerprint the sources of oil contamination and to determine quantitative values.

Although many samples were collected by NOAA, the bulk were submitted by other response agencies, including the U.S. Fish and Wildlife Service, ADF&G, ADEC, EPA, and Exxon. These agencies needed rapid analytical support to address response concerns that were shared by NOAA. Examples of this interagency cooperation included the analysis of tissue samples from beached grey whales to determine whether they had died as a result of EXXON VALDEZ oil. NOAA also analyzed a material, locally known as "white stuff," which began appearing in the affected areas of the Gulf of Alaska, to discern its chemical nature and potential toxicity. NOAA concluded that the substance was a natural

## Oil Analysis, *cont.*

decomposition by-product of dead marine life, commonly found even in unaffeccted areas In addition, analytical chemistry support was provided for NOAA's oil productivity study, and for the reviews of beach cleaners and bioremediation studies by the Interagency Shoreline Cleanup and R&D committees.

# Committees:

## I. Interagency Shoreline Cleanup Committees

NOAA chaired several committees comprised of Federal, State of Alaska, Exxon, and local interest groups. The Interagency Shoreline Cleanup Committee recommended cleanup actions to the Coast Guard based on consideration of environmental and cultural resources in the area affected by the spill. In concert with the committee, NOAA prepared and distributed to all spill command posts and resource agencies a 100-page shoreline cleanup training manual that used photographs, graphics, and text to specify the various types of cleanup methodologies to be used in the field. This manual was published in two editions, each edition reflecting updated knowledge, refined recommendations, and additional experience.

The shoreline committee developed a procedure to rank shoreline segments for treatment based on the degree of shoreline segment oiling and the presence or absence of ecologically, socially, or economically significant attributes. This process included the formation of Shoreline Cleanup Assessments Teams, Exxon scientists who surveyed each segment of the shoreline with respect to degree of oiling, presence of sensitive biological or cultural resources, and recommended treatment methodologies.

The committee also worked out specific protection strategies on a site-specific basis to deal with siltation, sheening, and disturbance of sensitive areas (e.g., eagle nesting sites, seal haulouts, seabird colonies, bears, Native artifacts, and historical sites).

The committee also reviewed toxicity data and field tests for several materials proposed for shoreline cleanup, including field tests on the oleophilic fertilizer Inipol EAP 22; a granular fertilizer; and shoreline chemical cleaners Corexit 7664, BP1100X, and Corexit 9580.

NOAA personnel stationed in Seward, Kodiak, and Homer actively participated in shoreline and Multi-Agency Committee working groups. These committees were comprised of local government, State, Federal, and Exxon responders who met daily to discuss operational issues of local concern, including shoreline cleanup, subsistence food contamination, and protection of the fisheries industry.

## II. Research and Development Committee

NOAA established and chaired a technical committee that met weekly to review the feasibility of applying new mechanical, biological, and chemical shoreline cleanup technologies to the spill. Technologies reviewed by the committee included dispersants and shoreline cleaning chemicals, bioremediation, and sorbent materials. The committee was comprised of representatives from the Alaska Department of Environmental Conservation (ADEC); Alaska Department of Fish and Game (ADF&G); the Coast Guard, EPA, Exxon; the U.S. Fish and Wildlife Service; the U.S. Forest Service; and the Chugach Alaska Corporation, the largest Native land-owning corporation in Alaska.

The committee's mission was to expedite the selection and testing of new shoreline cleanup techniques that could actually be implemented during the spring and summer of 1989. Because of the logistical requirements of field testing, most of the new technologies evaluated were closely coordinated with Exxon, using their cleanup crews and support equipment. Technologies taken to the field-testing stage were shoreline-cleaning chemicals, bioremediation using nutrient additives, peat, hot-water injection, and rock-washing equipment.

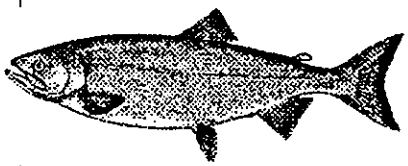
The committee addressed potential environmental impacts from the use of shoreline cleaning chemicals and bioremediation. Working with Exxon, the committee developed field-testing protocols to assure that each test satisfied agency requirements for documentation of effectiveness and the potential for impact to sensitive coastal resources. For shoreline cleaning chemicals, issues revolved around determining how the chemicals affected oil recoverability and whether they were toxic to nearshore water-column and benthic communities. The field-testing protocols were reviewed, revised, and finally approved for recommendation to the FOSC and the RRT. The committee's approval meant that very small-scale tests of effectiveness could be conducted, scaling up the tests as necessary to evaluate recoverability and toxicity.

Ten shoreline cleaning chemicals were field-tested initially; two were taken to larger-scale testing. The committee closely monitored all tests, made field observations, and collected samples for water column measurements of the concentrations of the oil and chemical in the water column, and for bioassays, complementing Exxon's extensive sampling efforts. For each test, the committee evaluated results and decided to revise the test protocol and/or scale-up the test to the next level of field testing. For shoreline-cleaning chemicals, the testing progressed to full-scale operational tests at the end of the summer, although unlimited use was never approved because of concern about the chemicals' effectiveness and ability to recover the oil. For bioremediation, the committee focused on agency concerns about the toxicity of the fertilizer formulation. The committee eventually recommended that the fertilizers be restricted from use in poorly mixed embayments since calculations showed a potential for short-term toxicity in these areas. Full-scale use, with some restrictions, was recommended in early August. Other techniques considered were not used because of ineffectiveness, limited potential for application in Prince William Sound, or inability to recover the released oil.

## Interagency Resource Meeting

Throughout the spring and summer, NOAA chaired an interagency meeting in which members of the scientific community working in Valdez met each evening to report on their ongoing research and spill response efforts. This forum included a summary by NOAA of daily aerial reconnaissance flights, a weather report and forecast, predicted changes in slick movement, and marine mammal surveys. Exxon reported on the status of shoreline cleanup, with contractors presenting updates on surveys to assess the extent of shoreline and water column contamination. The bird and otter rescue centers presented status reports on the numbers of animals received, treated, and released. The "science meeting" was also a forum for the presentation of marine mammal, fisheries, and intertidal survey results.

# Special Issues



In addition to formal committee activities, NOAA scientists worked continuously to resolve issues of particular concern to the Coast Guard, resource agencies, and local community. These issues included tracking the progress of treated shorelines, determining the quality of subsistence food products, protecting the fishery industry, determining the effectiveness of cleanup operations, and reviewing the use of shoreline-cleaning agents.

## Fisheries Protection

From the beginning of the spill, protecting hatchery areas and assisting fishermen in avoiding contaminated fish was of utmost importance due to the size and value of the catch in Prince William Sound and the Gulf of Alaska (Figure 2). These regions together produce the largest tonnage of halibut in the U.S.; Kodiak is the largest U.S. fishing port. Prince William Sound, alone, was expected to produce a record $70 to $100 million salmon harvest in 1989. Of the Sound's five salmon hatcheries, the Esther Hatchery supports the largest catch of pink salmon annually and is the only hatchery in the world to raise five species of salmon.

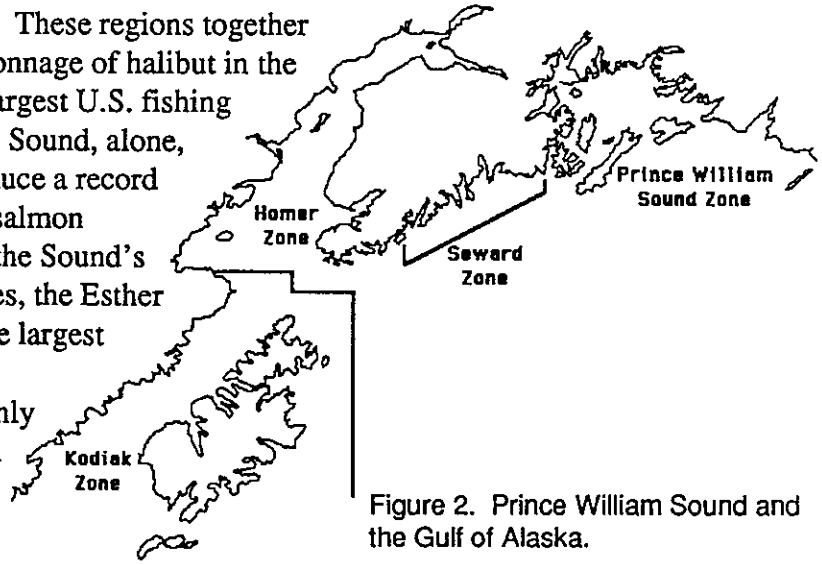



Figure 2. Prince William Sound and the Gulf of Alaska.

## Fisheries Protection, *cont.*

NOAA, working with the fishing industry and the State of Alaska, identified those hatcheries at highest risk from the spreading oil so that nearby waters could be protected by multiple tiers of boom. Daily NOAA overflights to reassess the effectiveness of these measures were combined with hatchery personnel assessments to develop further preventive actions. As a consequence of rapid and aggressive actions, none of the hatcheries reported significant contamination within the boomed areas.

In addition to protecting the hatchery areas, NOAA sought to ensure that an uncontaminated catch reached the market, and that the public remained confident that Alaskan fish were not tainted by the spill. ADEC and ADF&G issued a joint policy whereby commercial salmon fishing in the Sound would not be allowed in areas where oil was evident on the sea surface or nearby shore. This "zero tolerance" policy arose over national and international salmon marketing concerns of potentially oil-tainted fish, and resulted in season-long closure of most of the affected area. NOAA began working with the ADF&G in early May to provide information on the movement of the spill and the expected behavior and effects of the oil, as well as to assist them in opening other fisheries, where warranted.

The second major fishery to open was halibut, an offshore bottom fishery managed by NOAA's National Marine Fisheries Service and inspected by the State. Working with both governmental fisheries agencies, NOAA initiated a near real-time surveillance program two days prior to the 24-hour opening of the fishery to advise fishermen of the locations where oil had been sighted so that these areas could be avoided. Intensive overflights over prime halibut fishing grounds were conducted for three days by Exxon, the State of Alaska, U.S. Coast Guard, and NOAA. No contaminated halibut, vessels, or gear were reported.

The salmon fishery was the third major fishery to open, beginning in June. Early in the spring, ADF&G closed salmon fishing areas in the western Prince William Sound due to heavy contamination of the adjacent shoreline and periodic sightings of sheen from the shores. Other areas, primarily in the northern and eastern Sound, appeared not to have been affected by the spill and potentially could be opened to commercial fishing. Concern remained, however, over contamination spreading to these areas from heavily affected areas.

Discussions with ADF&G, fishermen, and the industry identified several sources of concern: (1) contamination from sheens from adjacent shorelines, many of which weren't always visible from the fishing vessels, and (2) contamination from "popweed," a floating brown algae that had been washed from oiled shorelines. In addition, there was always the concern that storms from the southeast would move oil from the western Sound northward into the remaining prime salmon fishing areas. To address these concerns, NOAA began routinely to present information on both sea and shoreline oil sightings at the weekly ADF&G Salmon Task Force meetings. The concern over catch contamination from oiled popweed

## Fisheries Protection, *cont.*

was more difficult to address than the contamination from floating oil since the amount of popweed, the degree of contamination, and the pattern of its movement once washed from the shoreline were all unknown, making evaluation of the size of threat to the fishery impossible to predict.

Working with Exxon, ADF&G, and staff from the Esther Hatchery, NOAA coordinated a program in the Sound to:

- estimate the amount of popweed in the northern area of the Sound through aerial overflights,
- evaluate the contamination of the popweed through sampling,
- calculate the probability of sheens or contaminated popweed being carried into the Esther Hatchery fishing area, and
- collect and wash contaminated popweed on a specially designed barge provided by Exxon and then relocate the washed algae should it be encountered during the fishing season.

Although the salmon fishery in the northern Sound opened on schedule, the season was not without incident. Daily overflights of the fishing areas were initiated by ADF&G, ADEC, and NOAA to provide information to determine the timing and size of the area to be opened to fishing, and later, to monitor the fishing area for oil. As predicted, large amounts of contaminated popweed were not found in the salmon fishing areas north of the spill area; however, sheens were sighted many times near to fishing vessels resulting in portions of the fishing areas being closed until the threat of contamination appeared to have passed. NOAA's oil model and the past spill experience of NOAA scientists had strongly suggested that there was a low probability of this oil being from the EXXON VALDEZ. To confirm this, NOAA analyzed water samples from the sheens collected by NOAA, ADF&G, and ADEC at the Coast Guard's mobile chemical laboratory in Valdez. Results showed that, in most areas, the oil was not Alaskan crude, but rather processed petroleum products commonly used by boats in their normal operations.

In Kodiak and Lower Cook Inlet, where such an intensive surveillance program was not initiated, most of the fisheries were completely closed.

# CAMEO-Valdez Information Management

By mid-May, the emphasis of the spill response had shifted from tracking floating oil to the treatment of the oiled shoreline. Vast amounts of information were flowing into Valdez from aerial overflights, ground-based shoreline assessment teams, and Coast Guard oversight teams supervising the cleanup. At the FOSC's request, NOAA designed CAMEO-Valdez, sophisticated microcomputer-based software that was used during the spill response as a daily briefing tool to track the progress of Exxon's shoreline treatment operations and forecast performance based on the most recent results (Figure 3).

The concept is based on another NOAA software product, CAMEO™ II, which helps emergency planners and first responders safely handle chemical accidents. Six NOAA programmers worked around the clock for nearly a month to develop and refine this data management system, which integrates interactive color graphics with complex charting and display capabilities. CAMEO-Valdez combines high-resolution maps of the impact areas, records of shoreline cleanup progress, an on-line version of the National Oil and Hazardous Substances Pollution Contingency Plan, and task force deployment statistics.

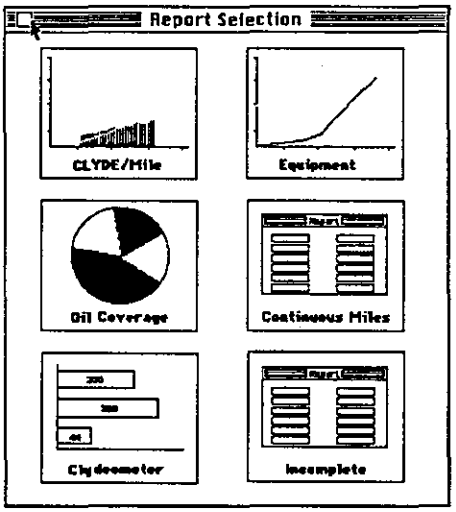



Figure 3. CAMEO-Valdez Briefing Reports.

# Food For Subsistence

The potential oil contamination of fish and shellfish caused considerable concern in Native villages in Prince William Sound, the Outer Kenai Peninsula, and Kodiak Island, and resulted in a reduction in subsistence fishing activity. Subsistence users in these villages rely, to a great extent, on fish and shellfish (in addition to deer and marine mammals) for a large percentage of the protein in their diet. A pilot study conducted by ADF&G in May collected a small number of fish and shellfish samples from Prince William Sound and Lower Cook Inlet subsistence areas. The laboratory analysis and interpretation of the results was conducted by the U.S. Food and Drug Administration (FDA).

NOAA signed a Memorandum of Understanding with Exxon in August to extend the ADF&G study and conduct the laboratory analysis for hydrocarbons in the tissue samples. Extensive collections of important fish and shellfish subsistence resources were undertaken during July, August, and September. Sites and species sampled were selected in consultation with Native experts from the villages.

## Food For Subsistence, *cont.*

NOAA and ADF&G biologists assisted Exxon in most of the sample collection efforts. The analyses were conductedby the Environmental Conservation Division of NOAA's Northwest and Alaska Fisheries Center in Seattle. Results are expected to be available in late February.

The project was coordinated through the Oil Spill Health Task Force (OSHTF), which had been meeting biweekly since early in the spill to deal with health-related issues. OSHTF is chaired by the U.S. Public Health Service, and includes the Alaska State Epidemiologist and representatives of the Indian Health Service, ADF&G, NOAA, Exxon, and the Native corporations, The North Pacific Rim and Kodiak Area Native Association (KANA).

To address the significance of the study's results from a human health perspective and to provide some external evaluation of the study, NOAA arranged for a group of toxicologists to meet in Seattle in September for a comprehensive discussion of analytical data obtained at that point. The group included representatives from NOAA, FDA, National Institute of Environmental Health Sciences, Agency for Toxic Substances and Diseases Registry, University of Alaska, and Exxon. The group's recommendations were the basis for a Health Bulletin sent to all native villages by the State Epidemiologist. The group concluded, based on the first round of data (July samples), that fish were safe to consume, but that shellfish from specific areas (e.g., Windy Bay on the outer Kenai Peninsula and Near Island across from the Kodiak boat harbor) should not be consumed. The group also emphasized the preliminary nature of the results due to the small sample sizes for the various areas and species included in the study, and the possibility of changing conditions.

In addition, Task Force representatives, including Exxon, ADF&G, NOAA, North Pacific Rim, KANA, and the Indian Health Service, travelled in October to each village to present the results, provide background on the toxicology of petroleum hydrocarbons, interpret the results from the tissue analysis, and answer questions.

After the final report is prepared, the expert committee will reconvene (tentatively scheduled for late February) to give an overall assessment and provide additional recommendations. Further sampling (primarily shellfish) is currently being planned for later this winter, spring, and summer. Additional work will provide a basis for long-term monitoring and will address specific data gaps identified by the villagers and the expert committee. Analysis of marine mammal samples and deer samples collected by ADF&G is also pending.

# Special Studies

## Oil Sheens in Northwest Bay

In June, NOAA conducted a series of overflight surveys of Northwest Bay on Eleanor Island to quantify the presence of oil sheens on the surface of the bay. The overflight series was designed to determine the cause of the sheens, whether the sheens were indicative of a significant quantity of oil, and, if the cause was related to poor containment of oil removed from the shoreline, decide on the actions that might be taken to mitigate the release.

NOAA conducted a series of ten helicopter overflights, five each day, on June 18 and 19. Between 0700 and 1900 each day, oil coverage on Northwest Bay was estimated to range from 153 gallons at the beginning of the survey to a low of 26 gallons at the conclusion of the survey. Observers also noted that a significant fraction of the oil escaping from the cleanup operations was released from booms around shoreline areas that were being actively washed, and leaching from sections of the shoreline not actively being treated. However, in general, it was concluded that the oil coverage on Northwest Bay was relatively low compared to the total amount of oil being processed and recovered from the shoreline.

## Cleanup Effectiveness

This study estimated the effectiveness of shoreline cleanup activities, specifically, of oil recovery from the shoreline over time and the relationship of biological impacts to the intensity of shoreline treatment. An Omni barge was selected as the treatment method because it not only provided more effective oil removal than other methods, but could also provide consistent water flow rates, pressures, and temperatures, and was representative of a technology being used to treat much of the oiled shoreline in Prince William Sound. Also, the Omni barge operated at the highest temperatures and pressures used in treatment, and thus would be the treatment type most likely to cause the greatest biological impact.

The objectives of the study were related to the following questions:

- What is the incremental change in oil removed from a heavily oiled shoreline with various durations of washing?
- What percentage of surface and subsurface oil is removed with various durations of washing?
- Does increased washing reduce biomass or otherwise disrupt ecological communities?

## Cleanup Effectiveness, *cont.*

NOAA, Exxon, and ADEC together planned experiments on a portion of shoreline segment KN-13 in Herring Bay on Knight Island. Experiments were carried out from July 16 to July 22, with follow-up work continuing until July 27.

The incremental change in the amount of oil removed from the shoreline was estimated by measuring the oil recovered in the skimmer following treatment of the shoreline for two durations of washings. Each test lasted two to four hours, the amount of time that the Omni operators would normally spend cleaning the site. A second site was treated for about half the time of the "normal" wash time for the first site.

The study concluded that the majority of the oil was released from the cobbles and surface sediments once the oil reached its pour point, estimated at 100°F. Since this temperature was reached within the first hour of treatment during both tests, longer washing durations appeared to have minimal influence on oil recovery. Biological effects data gathered by Exxon have not been released publicly.

## Shoreline Cleaning Agents

NOAA worked closely with other members of the shoreline and R&D committees in Valdez to evaluate the use of a number of shoreline-cleaning agents. Beginning in May, Exxon field-tested the chemical dispersants Corexit 9580 and BP1100X in Prince William Sound.

The decision to approve a large-scale test of Corexit 9580 in August was reached after an extensive program aimed at evaluating shoreline cleaning technologies. The monitoring program addressed three major issues: migration of oil and Corexit in shoreline sediments, the migration of sediments and oil in the nearshore environments, and the migration of oil in the water column, each being evaluated in the monitoring program. The dispersant's effectiveness and impact were then compared to mechanical shoreline cleanup methods, and this information was used to determine whether Corexit 9580 should be used for shoreline treatment. The R&D Committee recommended against broad-scale application of the product because tests had not adequately demonstrated that removal and recovery efficiency outweighed possible adverse effects. The committee recommended using Corexit only on Smith Island, subject to continued review of the effectiveness of recovery procedures by on-scene monitors.

# Winter Operations

Due to the prospect of inclement weather, Exxon discontinued cleanup activities on September 15, 1989. Although NOAA's spill response operations concluded for the winter on September 20, NOAA continues to work on spill-related projects, including surveys of the Prince William Sound shoreline to determine the need for additional treatment in the spring of 1990, preparation of a detailed hindcast trajectory of the oil spill's position over the course of the summer, and development of strategies for cleanup efforts to be undertaken when full-scale spill response resumes.

## Winter Monitoring Studies

This winter NOAA is conducting monthly surveys of a series of 18 stations in Prince William Sound to assess the degree of surface and subsurface shoreline oiling and the effectiveness of natural removal processes. These 18 stations, both treated and untreated, are considered to be representative of the many different types of coastline in Prince William Sound, including exposed, rocky shoreline; sheltered bays; and cobble beaches.

In addition, NOAA has installed and maintains seven meteorological stations in Prince William Sound and the Gulf of Alaska to relay weather data via satellite. Weather data are also relayed to Valdez to assist the National Weather Service in preparing forecasts for the benefit of people working in the sound during the winter.

## Hindcast Spill Trajectory

Using historical weather information from Prince William Sound and the Gulf of Alaska for times when no visual observations were available, NOAA has designed a mathematical hindcast model that graphically represents the spread of EXXON VALDEZ oil over time. The model uses calculations developed for NOAA's mathematical hydrodynamic model, the On-Scene Spill Model (OSSM), to determine approximate coordinates of the spill at three-hour intervals, beginning with the first day of the spill. Overflight data are used to recalibrate OSSM periodically to ensure that model results reflect visual observations of the spill. The hindcast model combines all overflight maps into one coherent presentation and can be used as a tool to estimate the percentage of oil that evaporated or beached in various locations.

## Cleanup Technology Review

In October, NOAA staff revisited the site of the ARROW oil spill in Newfoundland and the AMOCO CADIZ oil spill in France to evaluate the effectiveness of natural cleaning over time in cold environments. In January 1990, NOAA surveyed shorelines on the Washington coast affected by the NESTUCCA oil spill. All three sites still showed evidence of oiled beach sediment in sheltered areas, years after the spills occurred.

NOAA sponsored a workshop that met in Anchorage from November 28 through November 30, 1989, to discuss methods of cleanup that might be applied to the oil remaining on shorelines in the spring. Approximately 200 people attended, including scientists and members of the Coast Guard, Exxon, EPA, Alaska state agencies, local fishermen's concerns, private industry, and the news media.

Individual sessions addressed biological, chemical, and physical methods of cleanup, with speakers presenting evidence based on experience with previous oil spills or on experiments conducted in relation to the EXXON VALDEZ spill. The workshop's goal was for the attendees, the majority of whom worked on the spill this past summer, to come to a general consensus as to the nature of the technology to be used to treat the shoreline in the spring. Although little new technology emerged from the workshop, the attendees gained a collective perspective on technical details of the residual oiling problem to be faced in 1990. The workshop's proceedings are in press.

# Conclusion

Over 1,200 miles of shoreline and 10,000 square miles of open water in Prince William Sound and the Gulf of Alaska were oiled in varying degrees as a result of the EXXON VALDEZ oil spill. At least 35,000 marine birds and 1,000 marine mammals are known to have died as a result of being oiled. Over 10,000 cleanup workers attempted to remove the oil from the water and shorelines via manual, biological, and chemical cleanup methods, with varying degrees of success.

Virtually NOAA's entire Hazardous Materials Response Branch staff and many other NOAA personnel spent the summer of 1989 in Valdez and other small towns in Prince William Sound and the Gulf of Alaska, working with the Coast Guard, Exxon, State of Alaska, and other agencies to identify problem areas, research ideas, resolve issues, and to ensure that cleanup proceeded as rapidly as was effective.