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Alaska's Big Spill

Can the Wilderness Heal?

By BRYAN HODGSON
NATIONAL GEOGRAPHIC SENIOR WRITER

Photographs by NATALIE FOBES

It had always been inviolate, an archipelago of eagles and whales. But last March 24, 11 million gallons of oil assaulted Prince William Sound when the *Exxon Valdez* struck a reef. Three weeks later the tide washes oil from one fouled island among scores (following pages). Cleaning a beach, Alaskan Sonya Knight weeps at the wildlife loss. "Cry for one animal," a co-worker advised, "but work to save the rest" (left).

And work they did, for week after frustrating week, an army of 11,000 men and women pitted against the worst ever U. S. tanker spill. On May 23 about 180 workers attacked the stricken shore of Green Island with high-pressure hoses to break up the tarry residue and wash it to the water's edge for collection. Such methods, however, sometimes killed shoreline organisms. Exxon Corporation, responsible for the oil and its ill-fated tanker, will spend more than a billion dollars attempting to clean up one of the costliest industrial accidents in history. Another price: the withholding of scientific data about the spill because of pending lawsuits and damage claims.

A debate over whether to use chemical dispersants to break up the North Slope crude was rendered moot when hurricane-force winds broke up the black tide and drove it southwest. Eventually patches drifted 500 miles along the Kenai Peninsula to the Alaska Peninsula and Kodiak Island. Although volunteers struggled to save oiled seabirds, tens of thousands died. Local fishermen, galvanized by the threat to the sound's commercial salmon hatcheries, grabbed most of the available containment gear and sped to protect their livelihood.

IN THE BEGINNING, when the supertanker *Exxon Valdez* gutted herself on Bligh Reef and vomited 11 million gallons of crude oil into Alaska's exquisite Prince William Sound, it seemed truly like the ending of a world. Seabirds were dying by the thousands in the muck. Vast stocks of salmon and herring and halibut would perish next, naturalists feared, and with them an industry and a way of life. On the eighth day of the disaster I walked shorelines that glittered black as far as I could see. A pitiful handful of cleanup vessels confronted the largest tanker spill in United States history. What hope could there possibly be?

Five months later I walked those shores again. Incredibly I found pink salmon spawning in a stream that had been choked with oil, and I smelled fresh seaweed on a pebble beach where native bacteria had eaten much of the oil away.

Clearly the world had not ended.

Equally clearly, its rehabilitation had just begun. Throughout the sound and down the Gulf of Alaska as far as lower Cook Inlet and Kodiak Island, the damage had been staggering. Oil had drenched or spattered at least 1,200 miles of shoreline. Experts believed that as many as 100,000 birds had died, including some 150 bald eagles. At least 1,000 sea otters had perished, despite an eight-million-dollar rescue and rehabilitation program. Economic costs had been staggering as well: The state had canceled the opening of herring fisheries and restricted the salmon take, together worth more than one hundred million dollars a year.

Meanwhile the Exxon Corporation, owner of the ship and the spilled oil, had spent a billion dollars on a cleanup campaign in which some 11,000 workers had scoured beaches with everything from high-pressure hot-water jets to rakes and shovels and paper towels.

Now, as winter approached and Exxon closed down its effort, new controversies were added to older ones. Was Exxon quitting too early with the job half done, as state officials claimed? Had the cleanup actually done more harm than good? Many scientists now felt it time to let nature cleanse herself with the tides and violent storms of winter.

"Sometime in July the cleanup crossed the

ROY CORRAL/ANIMALS, ANIMALS (RIGHT)

Days after the spill, fishermen confront oily gunk a foot thick clogging a bay on Eleanor Island, about 35 miles from the wrecked tanker. Throughout the spill area, 36,000 dead seabirds, such as a grebe (right), were found—perhaps a third of those killed. Recovered animals were frozen for possible use as evidence in lawsuits; more than 150 have been filed against Exxon.

Staining the vista of the Chugach Mountains, the *Exxon Valdez* lies atop Bligh Reef two days after the grounding. Forty-two million gallons of remaining oil that would have vastly multiplied the disaster if the *Valdez* had sunk were pumped

into smaller vessels. Southbound from the trans-Alaska pipeline terminal at Valdez, the ship met disaster after 28 miles, outside normal shipping lanes, with the captain absent from the bridge.

line from being beneficial to being harmful. In effect, we created a second oil spill," I was told by Dr. Jacqueline Michel, a science adviser to the National Oceanic and Atmospheric Administration (NOAA). "Our tests showed large-scale mortality in beach organisms after some of the hot-water washes. Also, because of the flushing away of oil-coated sediments, we found up to ten times more hydrocarbons in the intertidal and subtidal zones than we did just after the initial spill."

Dr. Michel has researched the effects of oil spills for the National Science Foundation and NOAA since 1974, participating in studies of the *Amoco Cadiz* disaster, which dumped 68 million gallons of oil on the coast of France in 1978. Within three years scientists found that most of the major impacts had disappeared.

"The story is much the same in all crude-oil spills," she told me. "On exposed rocky beaches with much wave action, little oil is left after a year. On quieter beaches the oil persists from two to three years and is frequently mixed with sand and buried. Salt marshes suffer the most damage, and efforts to clean them are too destructive to do any good. In general, fish and bird populations tend to be replaced. The possible long-term effect on the tidal and intertidal ecosystems will take years to learn."

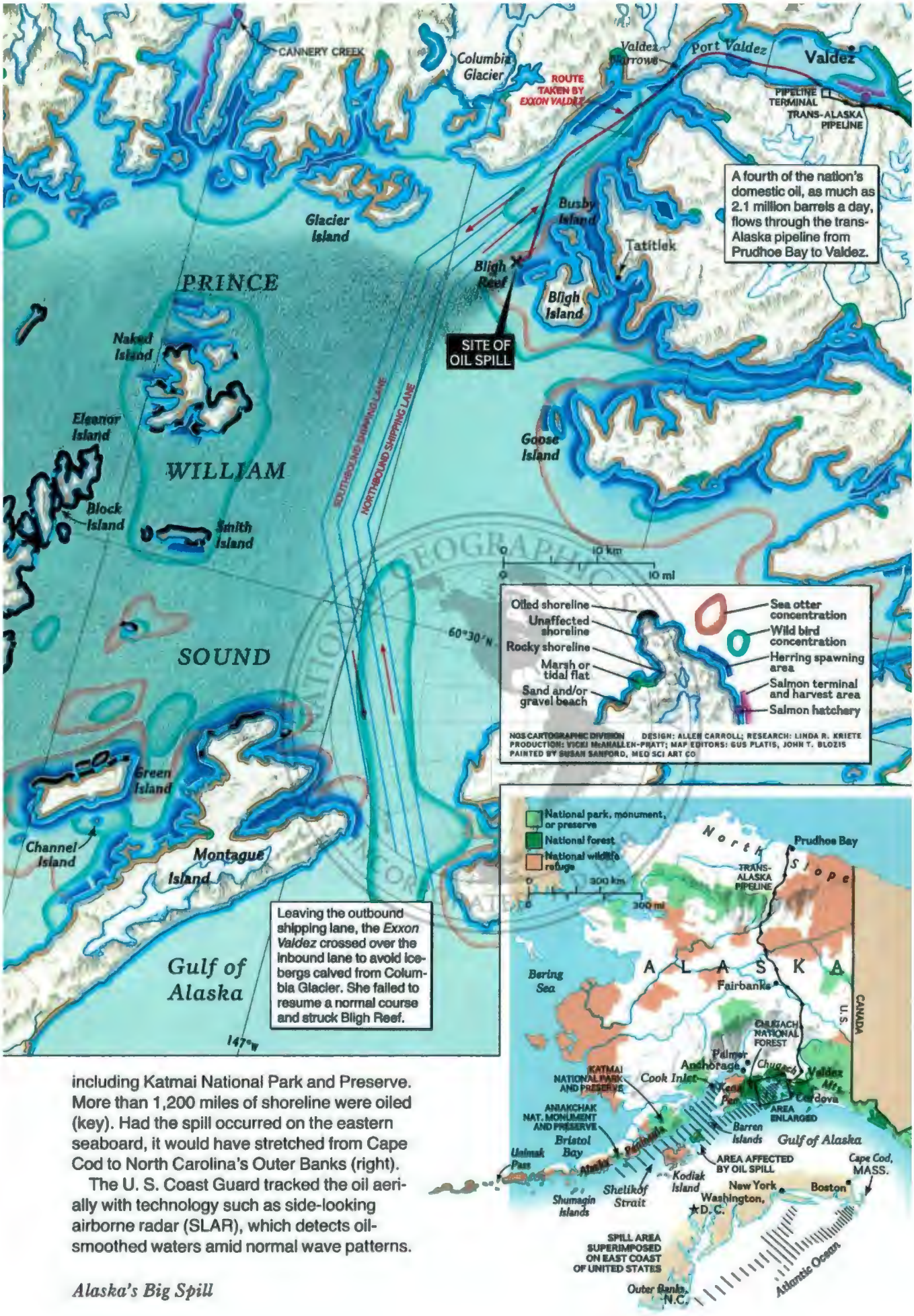
Such research was widely published before the *Exxon Valdez* ran aground in the first minutes of Good Friday, March 24, 1989. Coast Guard Vice Adm. Clyde Robbins, appointed to coordinate the responses of a welter of state, federal, and industry agencies, wishes the research had been more widely read.

"It was almost as though this spill was the first one we've ever had," he told me. "From the start we tried to establish committees to get organization into the activities. But people on the committees had never dealt with oil before. All they saw was oil, and they wanted it GONE! Everyone had a veto vote. And anyone who said 'maybe we should wait to see what nature does' was angrily questioned."

AS I TRIED to learn more about the long-term consequences of the spill, I found that many scientists were not permitted to discuss their findings. By congressional decree federal and state agencies are authorized to make a damage assessment that will result in a financial claim against the spiller sufficient to cover costs of complete restoration.

In harm's way

A vile amorphous blob, the oil inundated some shores yet left others untouched due to vagaries of wind and current. As it broke up and drifted to the Alaska Peninsula, the spill hit four national wildlife refuges, Chugach National Forest, and three national park areas,

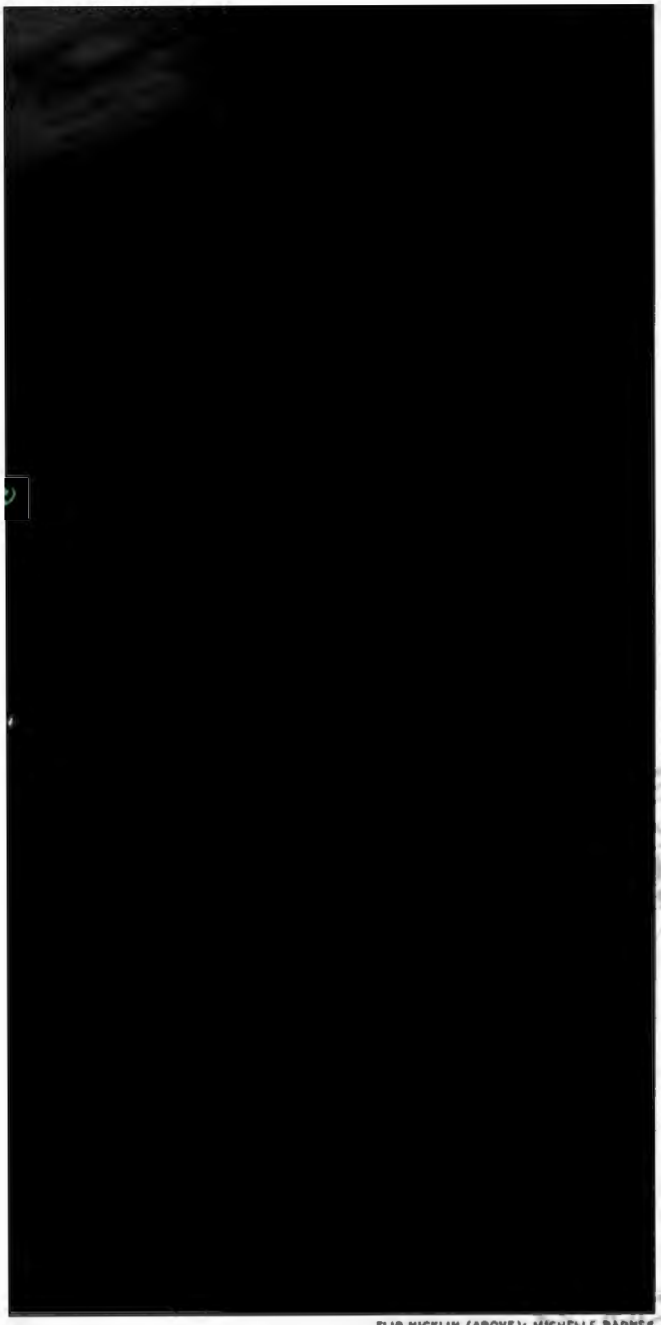


including Katmai National Park and Preserve. More than 1,200 miles of shoreline were oiled (key). Had the spill occurred on the eastern seaboard, it would have stretched from Cape Cod to North Carolina's Outer Banks (right).

The U. S. Coast Guard tracked the oil aerially with technology such as side-looking airborne radar (SLAR), which detects oil-smoothed waters amid normal wave patterns.

Alaska's Big Spill

Titanic impact left a huge boulder impaled in the hull of the *Valdez,* inspected by salvage divers off Naked Island. Submerged pinnacles had sliced open eight cargo tanks and three seawater ballast tanks. She was towed about 20 miles to safe anchorage there 12 days following the mishap. Tankers such as the *Exxon Baton Rouge* (right, at center) had earlier taken on most of the unspilled oil.



FLIP NICKLIN (ABOVE); MICHELLE BARNES

"We've been instructed that our work is litigation sensitive, so I can't comment or speculate about our findings," I was told by Kimbal Sundberg, a habitat biologist with the Alaska Department of Fish and Game. "But I can tell you what we plan to do. We will make a three-year study of the near-shore coastal habitat, from Bligh Reef to as far as the oil was carried down the Alaska Peninsula, almost to Aniakchak. We've established 98 oil-affected sites, which we'll study from about 65-foot water depth in the subtidal zone to the so-called supratidal zone, where oil has been splashed up by waves. We'll compare these with 28 control sites unaffected by oil—although these have been hard to find.

"But how do you put a price on a barnacle? How much for a limpet? Or a mink, a river otter? We're considering intrinsic value, not just a price tag. We're all heading for court. We'll have to make our case, and Exxon will certainly dispute. This adversarial science is unfortunately necessary."

Studying beach areas is not easy, he told me. One party on the Alaska Peninsula found that a brown bear had attacked their parked helicopter, raking the door and biting through one of the floats. "The weather is dangerous too, particularly in the bays along the Shelikof Strait. The winds there can go from 5 knots to 35 or 40 knots in five or ten minutes. Above all, we don't want to kill anybody."

If science is a forbidden topic, I wondered, how can I answer questions about the fate of the fisheries that loomed so urgently early in the spill? I set out to retrace the travels of two earlier visits and to piece things together as best I might.

MY FIRST EXPERIENCE coping with the spill had been on April 1, when I sailed aboard the Alaska state ferry *Bartlett* with a volunteer force of Cordova fishermen and high school students bound for Sawmill Bay on Eva[redacted] Island in Prince William Sound. There they would reinforce fragile threads of floating boo[redacted] protecting the Armin F. Koernig salmon hatchery. It was one of five such facilities that provide between 50 and 60 percent of the Prince William Sound pink salmon harvest, worth as much as 35 million dollars a year. A small fishing fleet had rushed to its defense in the first days of the spill.

We arrived on a brilliant morning after sailing through heavy patches of oil in nearby Knight Island Passage. There was a strangely festive atmosphere as volunteers launched shiny new aluminum skiffs onto sparkling waters. Their cargo: sorbent materials and booms in Easter colors of yellow, pink, and white.

I boarded a skiff with fishermen Tom Kohler and Jay Whitteker and watched the bright colors disappear as we collected globs of oil floating against the boom that protected the hatchery. It was impossible to stay clean. I remarked that the oil looked like sewage.

"I wish it was," said Jay. "At least it would biodegrade faster."

Later I toured the hatchery with manager Eric Prestegard. At a shoreline pen three

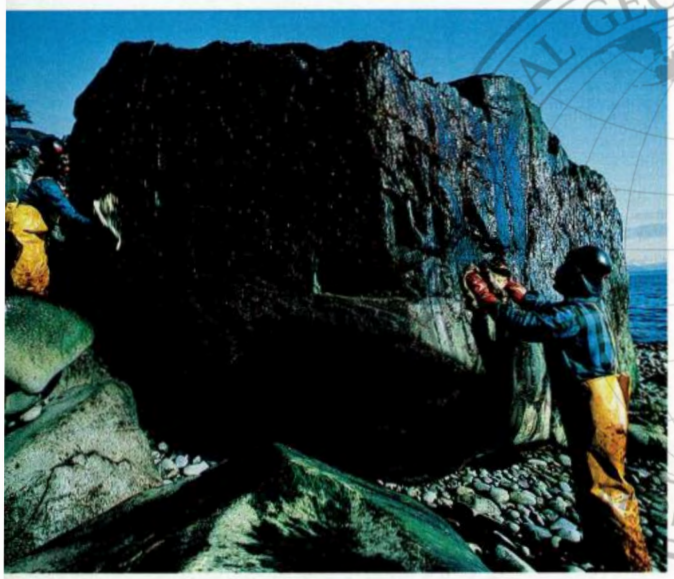
million inch-long pink salmon fry swarmed toward us to be fed. "Soon we'll be releasing four to five million fry a day. We must pen them up in incubation boxes and feed them until the zooplankton bloom begins between late April and early May," he said. "Normally they spend a month or two feeding on this zooplankton before they swim to the open ocean to mature. So we have two worries—that the oil will kill the fish and that it will kill the plankton."

Now, returning in mid-September, I wondered how things had gone.

"We never did get oil inside the boom. The fry went out on schedule, and all indications are they survived just fine," assistant manager Mark Somerville told me. "We had an incredible plankton bloom, the highest we've ever seen. There was no contamination."

The progress of the salmon fry was observed for two months by a team led by Ted Cooney of the University of Alaska's Institute of Marine Science. Like most scientists I had met, Dr. Cooney was deeply chagrined by the restrictions on communicating knowledge. But he described the study design:

"Starting on May 8, with three graduate students trained in salmon and plankton studies, we took daily samples of both the fry and the plankton they were feeding on. We measured growth rate and took flesh for hydrocarbon testing. Samples were collected both in Sawmill Bay and outside the bay, where the fry lingered for about ten weeks. We have two months of data to analyze, and we will be able to compare it with a baseline study done in the late 1970s."



Boom and bust characterized most of the de-oiling effort. Workers wipe soiled boulders on Naked Island, a practice widely derided as "rock polishing." More waterborne oil often came ashore to render such efforts useless. Besides earning $16.69 an hour, some participants felt fulfilled by doing something—anything—positive for the environment. Equally determined, a pair of fishermen tow a boom with their seiners to skim a fraction of the oil coating Herring Bay, one of the sites most heavily fouled during the initial onslaught. Everywhere the oil quickly thickened, preventing efficient collection.

BEFORE MY VISIT to Sawmill Bay, I had first flown with Alaska Governor Steve Cowper to see Tatitlek, an Aleut village only six miles from Bligh Reef. Alaska natives throughout the spill zone depend on subsistence hunting and fishing and were deeply afraid that their livelihood and way of life was being poisoned.

"Right now, herring are spawning. The salmon and ducks are coming in. It's scary because we don't know what's happening," said village elder Ed Gregorieff, 65.

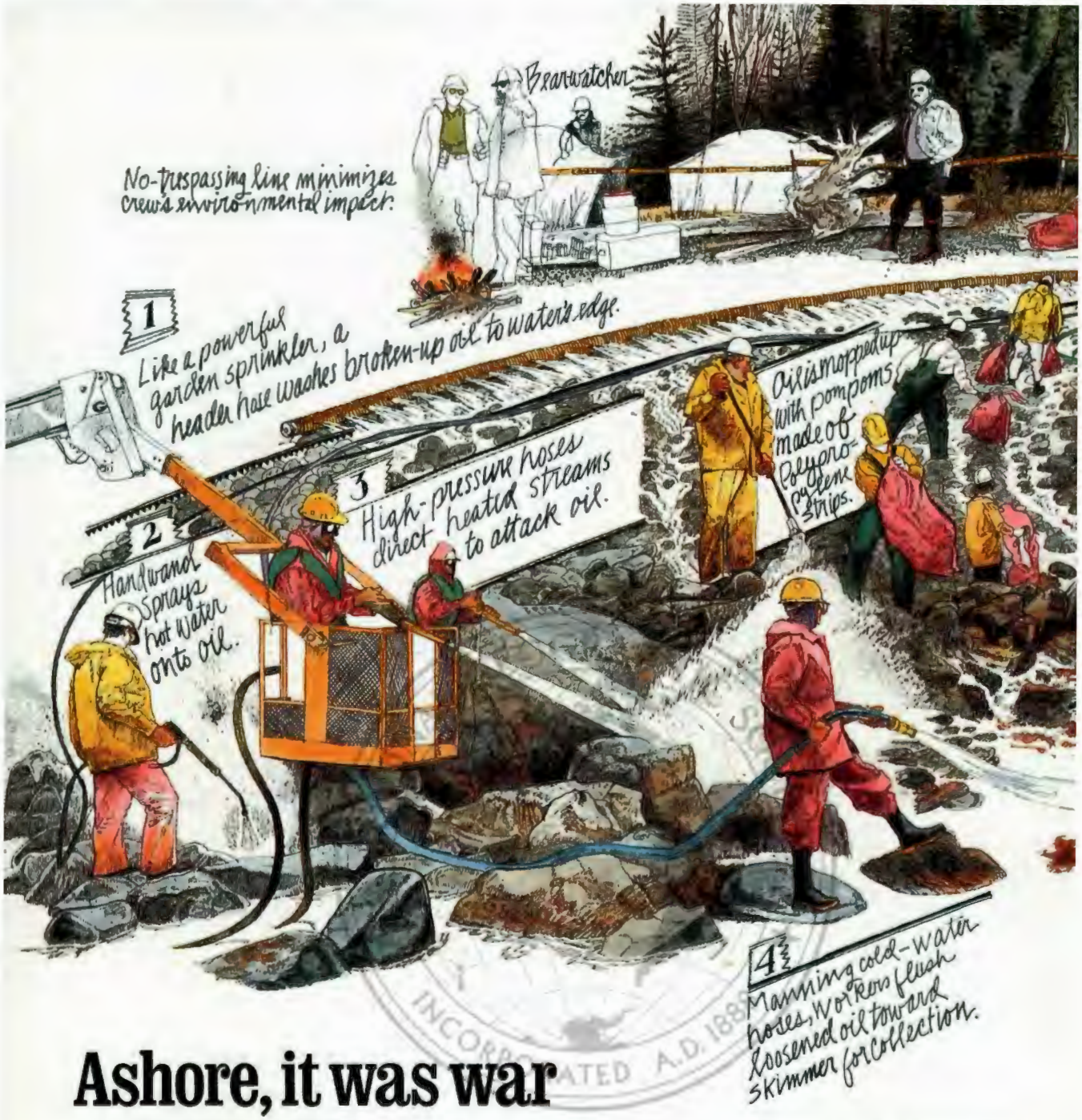
Governor Cowper replied: "If you're damaged, we need to know how much, and we'll try to get you a check. For now we're going to test mammals and birds for toxicity, so you'll know if they're safe to eat."

By mid-September the promise had produced some encouraging news.

"We have tested 5,000 fish sent in by state inspectors and by native subsistence fishers, and so far we have found no crude-oil contamination," I was told by Richard Barrett, head of the state's Division of Environmental Health laboratory at Palmer.

Barrett and his staff first inspect the fish. Anything that looks remotely like oil is picked up on an oil-absorbent pad, diluted with a chemical called hexane, and exposed to ultraviolet light. Hydrocarbons fluoresce brightly, and so far no crude oil has been found.

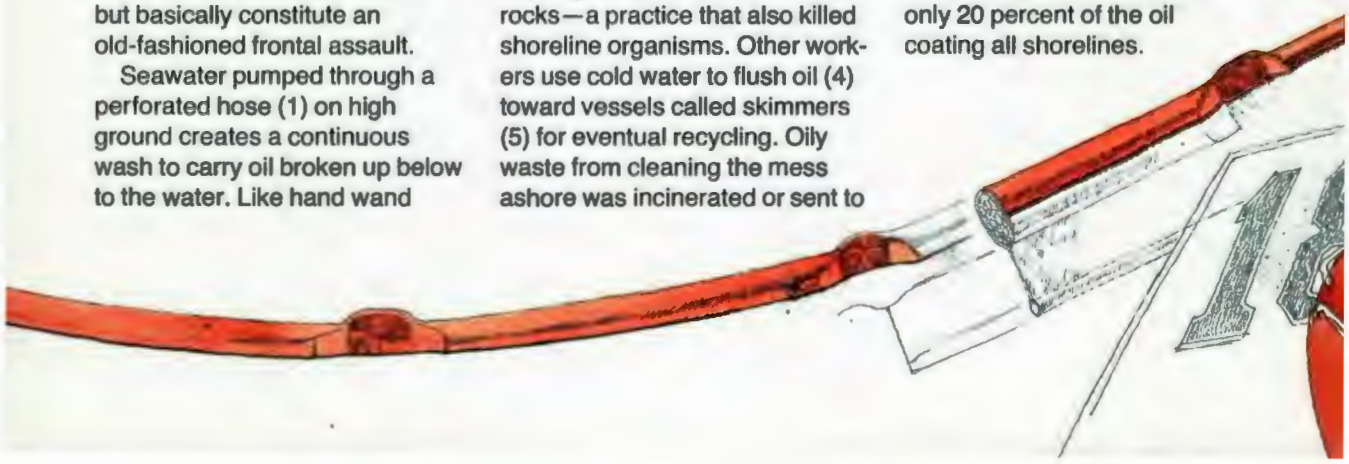
"Next we do what is called organoleptic testing—meaning to look, smell, and taste," Barrett told me. "We place samples of flesh in sealed jars, heat them in a microwave oven for a few seconds to volatilize any possible hydrocarbons, and then smell each sample. Next the samples are cooked completely, and we taste



Ashore, it was war

Engines roar through a Prince William Sound cove as an amphibious squad attempts to clean an oil-blackened island. Their tactics look sophisticated but basically constitute an old-fashioned frontal assault.

Seawater pumped through a perforated hose (1) on high ground creates a continuous wash to carry oil broken up below to the water. Like hand wand wielders (2), technicians in a hydraulic lift (3), often employed to reach cliffs, use high-pressure hoses with 140°F water heated on barges to blast oil from rocks—a practice that also killed shoreline organisms. Other workers use cold water to flush oil (4) toward vessels called skimmers (5) for eventual recycling. Oily waste from cleaning the mess ashore was incinerated or sent to toxic-waste dumps. Containment booms with foam flotation employ a flexible skirt below the water to keep oil from escaping. Such efforts may have removed only 20 percent of the oil coating all shorelines.



PAINTING BY JACK UNRUH
CONSULTANTS: JOHN ROBINSON, NOAA HAZARDOUS MATERIALS RESPONSE BRANCH; JACQUELINE MICHEL, RPI INTERNATIONAL, INC.

each one. You can't mistake it if anything is there."

Reassuring as they were, the test results weren't enough for some natives.

"On Kodiak they thought organoleptic testing sounded too primitive. They had heard so many reports of oiled fish that they demanded highly specialized laboratory tests," I was told by Ann Hayward Walker, a NOAA scientific support coordinator, who had just returned from a three-week survey of native villages from Prince William Sound to Kodiak.

THESE TESTS quickly became a high priority for Usha Varanasi, director of NOAA's Environmental Conservation Division in Seattle. "We have taken halibut and salmon from native villages in Prince William Sound, the Kenai Peninsula, and Kodiak and tested them using high-performance liquid chromatography as well as gas chromatography/mass spectrometry," she told me.

"So far we have found no hydrocarbons in their flesh, except for a few pink salmon from Kodiak that contained some traces in the parts-per-billion range. Fish are very efficient at converting hydrocarbons they ingest into metabolites and excreting them from the liver to the gall bladder. Consequently we would expect flesh contamination to be slight.

"Shellfish are not efficient, and we have found contaminated clams and mussels from Windy Bay, Chenega, and Kodiak—sites that were severely impacted by the spill."

NOAA scientists have tested 900 halibut for the Halibut Commission, finding no contamination. To assist in damage assessment, the NOAA research ship *Fairweather* has sampled hundreds of fish and shellfish, and spawning fish have been studied to detect any reproductive dysfunction.

"We are studying a system that has never been severely impaired by pollution, so if there are any problems, they should be evident fairly quickly," Dr. Varanasi said. "For the subsistence people, we have put everything we have behind the program. I am delighted we can discuss the results of our tests."

More cautiously, Al Maki is willing to discuss his work as well. He is Exxon's science adviser, with a 20-million-dollar budget to study the spill through spring 1990.

"We've selected more than 300 people with the best credentials in the country to do an accurate, science-based assessment of the spill," Dr. Maki told me. "We now have thousands of water and sediment samples from Prince William Sound through Kodiak and the Alaska Peninsula. Our data clearly show that hydrocarbon concentrations in the water remain at relatively low background levels—levels in the low parts-per-billion range.

"To date we have seen no substantive effects on the extent of herring spawning. We've sent divers down to take samples of eggs from both exposed and unexposed areas, and we've hatched the eggs in the lab and rigorously tested the fish embryos.

"We've also examined young and juvenile herring, which spend their first two months in the intertidal and subtidal zones. Initial results showed good survival. We've taken tissue samples to test for hydrocarbons, but we are still awaiting the results.

"As for pink salmon, this spring we were concerned with the out-migrants that came down the streams at the time of the spill. What happened? We used wire cages called live cars and placed salmon fry in them at both exposed and unexposed sites. The data are convincing: We monitored the samples for two weeks, and there were no oil-related mortalities.

"Now we are measuring escapement—the number of salmon that successfully returned to their native streams to spawn. Here we developed a new technique using a video camera mounted beneath a helicopter and a computer-enhanced image that enabled us to get an actual hard count of spawning fish, not just an estimate. We have done this on more than 50 streams. And this year there was a very large spawning run.

"To follow the actual spawning, we placed eggs in more than 200 sample containers and buried them in the gravel beside the naturally deposited eggs in both oil-affected and non-affected zones. We will pull sample boxes throughout this winter to see what effects there may be."

FOR ME one of the most distressing moments of the spill came when I heard orphaned newborn seal pups utter their strangely human cries at a rehabilitation center in Valdez. They had been brought in from Herring Bay, on Knight Island, one of the most heavily oiled sections of the sound.

Although seals come under the jurisdiction

Blotting oil with a paper towel, Sophie Katelnikoff (below) spends Mother's Day doing what she can for a beach near her village of Larsen Bay on Kodiak Island. A friend wields a spoon against the oil, now transformed into a thick emulsion called mousse. Villagers feared its effects on offshore clam beds. Along the southwestern end of the spill, officials protested vigorously when impact was generally assessed as less severe than in the sound.

BRYAN HODGSON, NGS STAFF (ABOVE); KEN GRAHAM PHOTOGRAPHY

Rare good news may come from an experimental project called bioremediation, designed to promote the growth of microorganisms naturally present in the environment that break down oil. Technicians spray a nitrogen-phosphorus fertilizer mix on an oil-laden shore of Green Island in hopes of stimulating oil-eating bacteria. On a nearby island a test grid shows noticeable improvement in a treated area (right, at right) compared with an untreated plot, at left and above. By September a stretch of Green Island has recovered dramatically (above).

The technique, long employed against toxic wastes, could double the speed of natural oil removal.

Netting a sad harvest, Jerry Patton collects birds that perished on Channel Island. They were analyzed in Valdez, as were Green Island victims including a sea otter and a loon (right). Concern ran high for some 5,000 bald eagles, such as this adult with an oiled head en route to a rehabilitation center. Nearly 150 eagles are known dead. Long-term effects may plague others that scavenged contaminated carrion.

of NOAA, they also become the concern of the Alaska Department of Fish and Game when they "haul out" to give birth or molt onshore. That casts state biologists Kathy Frost and her husband, Lloyd Lowry, in the role of foster parents.

"The seals are molting now, so they have shiny new coats," Frost told me in September. "They are hauling out to sun themselves, and I hope the areas are clean enough so they can go into winter with clean coats.

"It will be at least three to six months before we can tell what effects the oil has had. We're waiting in line for lab tests. In October we'll collect a few more animals for study and hope to have comparative tissue analyses by then.

"We never saw a lot of seal deaths that could be attributed to oil. Some premature pups were picked up, but they could have been natural abortions. We found several newborn pups that may never have taken a breath. The mothers had a lot of stress, both from the oil and from human activity.

"Not many dead seals were found. The number of carcasses was fewer than 30. Seals sink when they die, and that's why they are hard to find.

"We're doing aerial surveys of 25 areas and comparing the results with similar studies done in August and September of 1984 and 1988. But there was an unexplained drop of 40 percent in the population between those years, so we will not get a good comparison. On Tugidak Island, south of Kodiak, for instance, the population dropped from 10,000 to 2,000, and nobody knows why. Starvation might be one reason. Pollack is one of our largest fisheries here—but it is also a key prey species. We can't maximize fisheries and marine mammals at the same time."

MAXIMIZING SAFETY at the expense of fishing became a priority early in the spill when state officials announced a "zero tolerance" policy that prohibited fishing in any area where oil was reported. The policy, designed to protect consumers and to preserve the untainted image of Alaska fish on world markets, had some unintended results.

"I hope the state realizes what zero tolerance means," I was told by David Kennedy, NOAA science coordinator. "In addition to Exxon oil, our laboratory has found that fisheries were closed for bilge oil, diesel oil, and

Perils of petroleum for wildlife

Although death came quickly for many birds and animals, the scientific jury is still out on the oil's long-term effects.

Sea otters' physiological systems were ravaged. The only sea mammals that lack thick blubber, many succumbed after their dense fur became saturated with oil and provided no insulation. Others developed respiratory ailments, possibly because volatile elements of the oil weakened membranes in their lungs. Some suffered liver and kidney damage, probably caused by ingesting oil while cleaning their coats. Within the affected area, more than a thousand otters are known dead, perhaps a third of the total killed.

Similar maladies afflicted common murres, one of the area's most abundant seabirds. Murres that had gathered on the

water in huge rafts prior to breeding were fouled en masse. Oiled feathers (inset) lost their insulating ability and hypothermia set in.

The oil invaded the food web when predators such as bald eagles scavenged oily seabird carcasses, carrying them to their nests and contaminating eggs or young. Of 125 eagle nests surveyed, two-thirds failed last year.

PAINTING BY JACK UNRUH
CONSULTANTS: TOM WILLIAMS, MONTEREY BAY AQUARIUM; D. MICHAEL FRY, UNIVERSITY OF CALIFORNIA, DAVIS

Oil degrades seabirds' red blood cells, shown normal at left, into wrinkled and pitted cells, at right, that cause a form of anemia.

hydraulic fluid. There's a certain amount of oil associated with any fishery, and this policy, if enforced in the future, could continue to cause routine closures without any Exxon oil."

KODIAK, along with the Kenai and Alaska Peninsulas, received little attention in the early days of the spill. This was true even though broad patches of sheen—a coating often only thousandths of an inch thick—accompanied by evil-looking streamers of an oil-water emulsion called mousse were drifting down from Prince William Sound.

But in early May a dramatic press conference by officials of Katmai National Park and Preserve announced that 90 percent of Katmai's 260-mile coastline had been devastated.

To check those early reports, photographer Natalie Fobes and I boarded a single-engine Bell LongRanger helicopter for the 80-mile trip from Kodiak. At Hallo Bay, on a broad expanse of beach, we found Kodiak fishermen Ed Stiles and Kelsey Crago, who had been hired by Exxon to look for oil and dead birds.

"We've picked up about 3,000 birds in the last five days," said Crago. "Most of them were murres, killed around the Barren Islands northeast of here. They keep drifting in with the tide. We're collecting the bodies to keep the bears and eagles from eating them."

The bay was smeared here and there with oil and tar balls. A bear had left oily footprints on driftwood logs. "This is the prettiest place in the world—as long as you don't look down," said Stiles.

Just to the north, at Cape Chiniak, we found a party of 20 workers loading a small landing craft with hundreds of blue plastic bags filled with heavy oil. "It's ironic, but we can earn more shoveling oil than we can fishing for cod," said one of the workers, Paul John "Tiny" Smith of Albany, Oregon.

Compared with the oil-drenched shorelines of Prince William Sound, which had absorbed about 90 percent of the spill, the damage here seemed light to moderate. On Kodiak and Katmai those definitions are fighting words.

"We consider this oiling to be an ultimate insult to a national park," Jay Wells of the National Park Service told me. "It will be years before we know what damage has been done to the bear and eagle populations and to the shoreline ecosystem itself."

Next day the oil-spill rumor mill provided

For a sea otter named Lazarus, there was a resurrection.

He showed up as yet one more emergency around 11 p.m. on April 14 at the Valdez Sea Otter Rescue Center, one of four such facilities that cared for the creatures. To this makeshift hospital set up in a college dormitory, a steady stream of otters slathered in oil had been arriving for two weeks by helicopter, boat, or even in cardboard boxes delivered by good samaritans.

It had been another long day; the staff of two dozen was exhausted. Ken Hill, a veterinarian from Cordova, examines the latest victim (above), a male picked up by a rescue vessel. Delivered in a pet carrier, he was barely moving.

His breathing stops. So does his heart. "He's had it," Ken says.

Everyone hears that, and no one accepts it. An oxygen mask goes over the otter's muzzle. An intravenous tube goes into his leg. Warm saline solution is injected under his skin, and he is laid in a warm bath. Ken holds his jaws open with a bar (top right) as a syringe is connected to a tube that carries both an energy booster and an activated charcoal slurry—to counteract the oil's toxicity—into the animal's stomach.

When he was out of danger, "a cheer went up," says Terrie Williams, a physiologist working with Ken (middle right, at right) during a two-hour washing with liquid detergent to clean the fur of the patient, which the staff named Lazarus by appropriate acclamation. A far more laid back Lazarus

(left) is one of about 200 otters now returned to the sound and waters beyond, some with radio transmitters implanted to signal their locations.

Terrie, based at the University of California, San Diego, reports that about half the 156 otters brought to the Valdez center were saved. Of the otters she tested, all the survivors had toxic hydrocarbons in their bloodstream at a concentration of 200 parts per million or lower, while those that died showed higher levels.

me with an unexpected bonus. Orders came from Washington to dispatch a Coast Guard and NOAA team, equipped with a sophisticated mobile laboratory, to prove or disprove alarming reports that large quantities of oil were heading for Chignik Bay and possibly Unimak Pass at the end of the Alaska Peninsula. With help from Lt. Comdr. Ken Elmer, commander of Coast Guard flight operations at Kodiak, I flew on a C-130 Hercules 360 miles southwest to a gravel landing strip at Sand Point, a fishing village in the Shumagin Islands. From there a Coast Guard H-3 amphibious helicopter made the 80-mile final leg to Cold Bay, a deactivated Strategic Air Command base that more than lived up to its name.

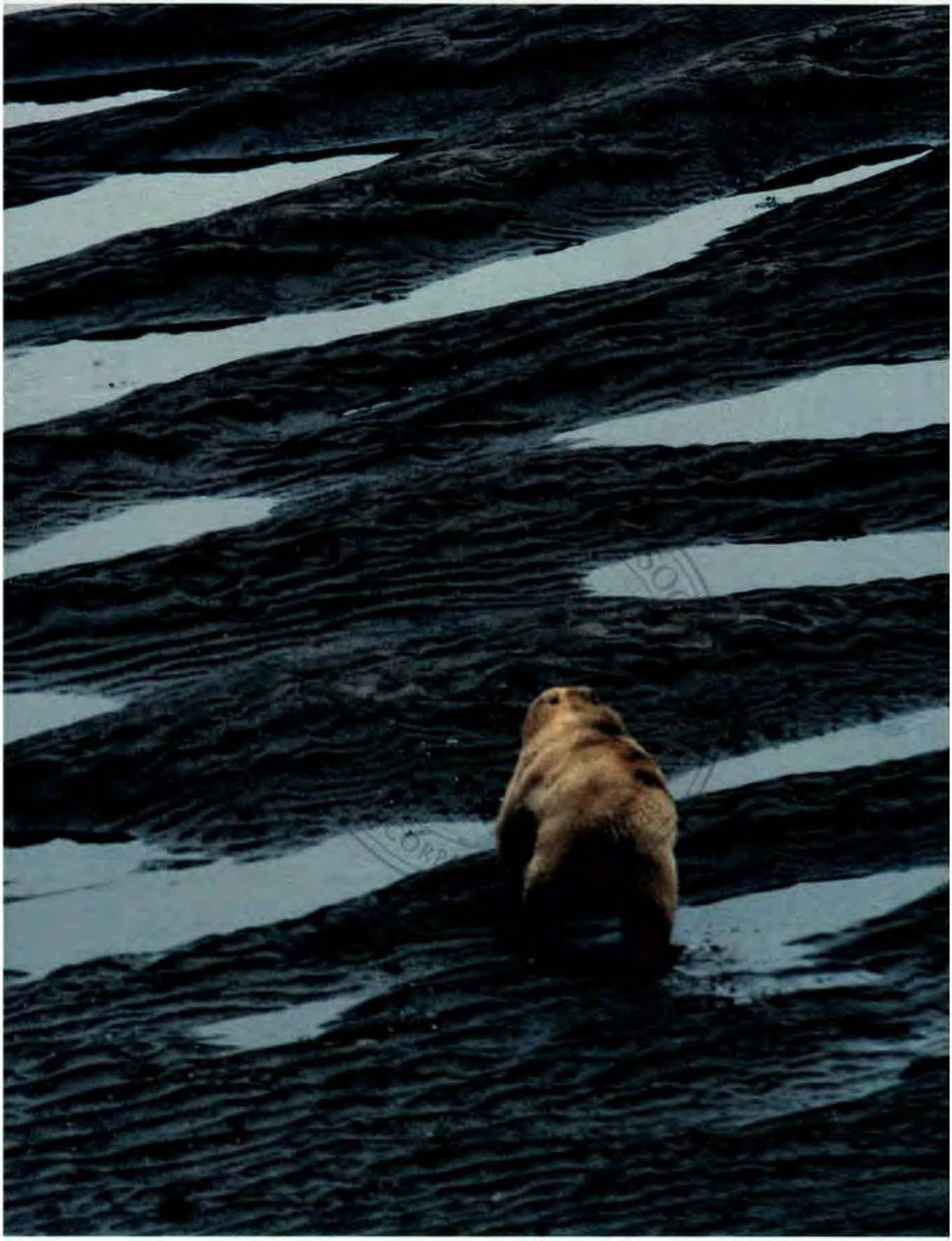
What followed was a magical two-day tour of remote islands and coastal bays, of deserted beaches piled high with logs splintered by ferocious storms. The peninsula is a beachcomber's paradise of random wreckage from the vast Pacific, and a naturalist's paradise as well. Foxes and wary gray wolves observed our passage, and we surprised dozens of huge brown bears as they lumbered along well-trodden shoreline "bear highways" with plump cubs in tow.

But we found no oil until the second day, when the familiar patches of silvery sheen appeared in the Shelikof Strait as we returned to Kodiak.

"We are called to 25 oil spills each year, from grounded vessels and fueling accidents," I was told later by Paul Gates, the U. S. Department of the Interior's regional environment officer and a member of the interagency regional response team established by federal law to respond to spills of oil and other hazardous materials. "Usually we take them in stride, but on this one, emotions overwhelmed everything almost from the start. Now we've issued instructions to first confirm oil sightings before reporting them—and report to federal officials, not to the press."

By contrast, emotion seemed eerily absent at a five-day hearing held in Anchorage in May by the National Transportation Safety Board

Land mammals also run afoul of the spill, with uncertain consequences. A brown bear's grimy legs and back show the oil it encountered elsewhere on this beach in Katmai National Park and Preserve. Bears, river otters, and foxes may scavenge oil-coated seabirds.



(NTSB) to investigate the causes of the *Exxon Valdez* accident.

According to witnesses the tanker's captain, Joseph Hazelwood, had boarded the ship and retired to his cabin for some two hours while a harbor pilot guided the ship in darkness through Valdez Narrows. Returning to the bridge when the pilot was dropped off, he ordered a course change to 180 degrees to avoid icebergs coming from the Columbia Glacier. He then switched the steering mechanism to automatic pilot.

At about seven minutes to midnight Hazelwood went to his cabin, leaving Third Mate Gregory Cousins and seaman Robert Kagan with instructions to steer back to the regular traffic lane when the ship came abreast of Busby Island.

Instead, according to instrument records, the giant tanker continued in a straight line for 11 minutes, veering only slightly to the right a few seconds before crashing onto Bligh Reef at four minutes past midnight.

On the witness stand Cousins testified that he had switched off the autopilot when Hazelwood left the bridge. When the ship reached Busby Island, he ordered helmsman Kagan to turn the ship ten degrees to the right. When radar showed the ship was not turning, he called for 20 degrees right rudder. About two minutes later, Cousins said, "I looked at radar, didn't like what I was seeing," and ordered hard right rudder. Then he telephoned Hazelwood and said, "I think we're in serious trouble." As he spoke, the ship ran aground.

Second Mate Lloyd LeCain, the navigation officer, who came to the bridge minutes after the disaster, testified that the ship's steering gear appeared to be in order. When the ship was on autopilot, he said, turning the wheel would have no effect on the rudder.

"The only people who know exactly what happened on that bridge that night are the captain, third mate, and Mr. Kagan, and anything else is irrelevant," LeCain said.

Hazelwood, under criminal indictment, did not attend the hearing, but his voice was heard on official Coast Guard tape recordings made on the night of the wreck.

At 27 minutes after midnight, he radioed:

"Yeah. . . . We've . . . it should be on your radar there . . . we've fetched up hard aground north of Goose Island off Bligh Reef. And, uh, . . . evidently . . . leaking some oil, and . . . we're gonna be here for a while, and . . . if you want . . . so you're notified."

Chief Mate James Kunkel told of the drama that followed. Racing to the control room, he saw that the ship was listing to starboard while eight cargo tanks gushed oil at some 200,000 gallons a minute. He told Hazelwood that the ship would capsize if it came off the reef.

"I feared for my life . . . ," Kunkel said. "It was the worst thing I'd ever been involved in. . . . I wondered if we were going to see the sunrise."

Nevertheless, Hazelwood tried to free the ship. Almost 45 minutes after the accident, he radioed to Valdez Coast Guard Comdr. Steven McCall that he was having "a little problem here with the third mate, but . . . we're working our way off the reef. . . . The vessel has been holed, and . . . we're ascertaining right now, we're trying just to get her off the reef, and . . . we'll get back to you as soon as we can."

WHEN I RETURNED to Valdez, I learned how close the *Exxon Valdez* had come to inflicting an unimaginably worse disaster by spilling her entire 53-million-gallon cargo into Prince William Sound.

"I'd never seen that much hull damage—I was sort of awestruck. One rock was broken off eight feet inside the hull," I was told by Rick Wade, owner of R&R Diving Services, who was called by the Coast Guard to make an emergency underwater survey of the ship at daybreak on Good Friday.

He showed me a videotape recording of the gaping wounds along some 600 feet of the hull, attesting to the enormous inertial force with which the 30,000-ton ship, laden with more than 170,000 tons of oil and moving at 12 knots, disembowelled itself on a series of reef pinnacles before finally grinding to a precarious halt on a narrow ledge.

The video sound track captured the agonized groaning and creaking of steel on stone, like an eerie voice of tragedy.

"The reef was being ground to gravel by the hull while I was down there. It wasn't a comfortable place to be. The ship could have come off the rocks anytime," Wade said.

John Tompkins, Exxon's salvage manager, agreed: "We had an unstable vessel," he told me. "Eight cargo tanks and three ballast tanks were holed. She would have gone

With a tender nudge, an oiled female harbor seal in Herring Bay shows she still knows her pup despite its own oil-blackened skin, creamy white underneath. Many seals killed by oil sank out of sight, making a tally impossible.

With so little known of oil's effects on marine mammals, scientists seized a chance to examine a gray whale that washed ashore on Kodiak Island. Cause of its death is still under investigation.

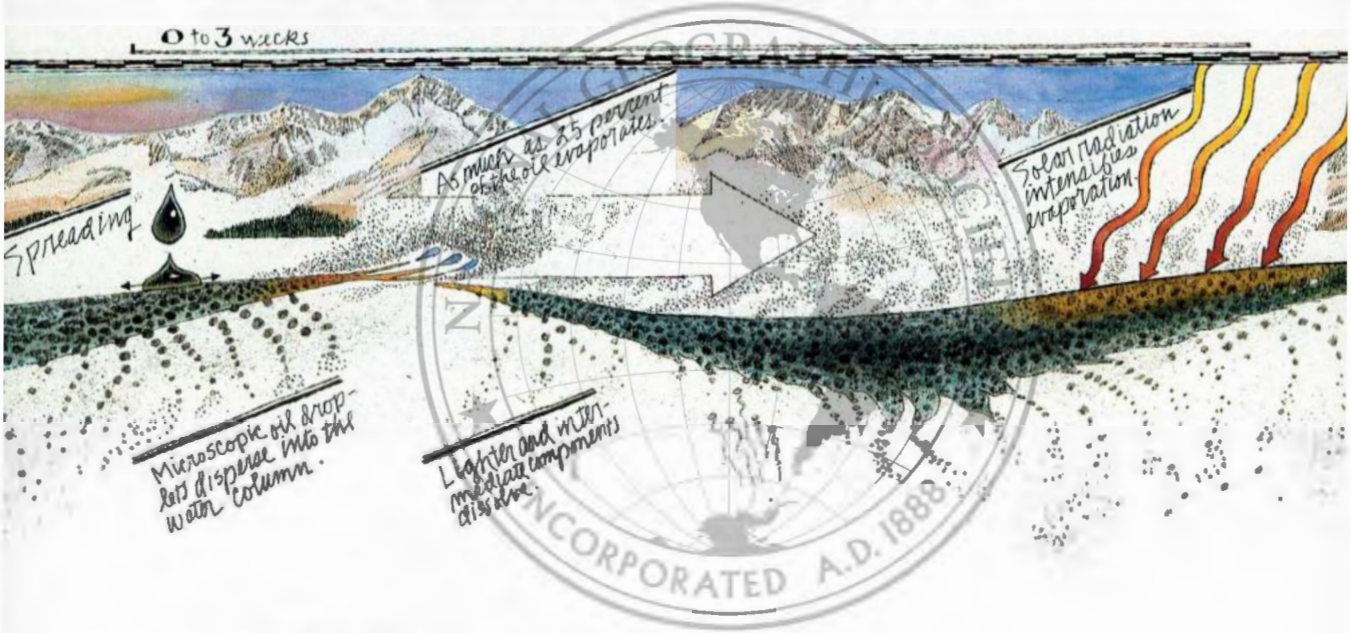
down eventually if she had come off the rocks that night. She still had more than 42 million gallons aboard—80 percent of her original cargo—and we wanted very much to spill no more. We had to find a way to take cargo off and get ballast water in without moving the ship. If we had done it wrong, she could have slid off the shelf. When we got the 70-knot winds, there was much anxiety and fear."

THE FIRST to start emptying the tanker were members of the U. S. Coast Guard Strike Force, an oil-spill response organization based in California and Alabama, equipped with pumps, booms, and oil-pickup gear designed to be air-dropped at the scene of a spill.

"We flew in on Good Friday with five high-volume pumps," said Lt. Comdr. Gary Reiter, commander of the Pacific Area Strike Team, which is based near San Francisco. "On Saturday we were on the tanker transferring cargo."

The team also brought along several oil-skimming units, which include a 612-foot containment boom with skimmers and a self-powered floating pump unit designed to be towed by so-called vessels of opportunity at the spill site. In Prince William Sound the opportunity fell to the Coast Guard cutter *Sedge*.

"If we'd had one of these skimming units operating in the first week, we could have collected 600 gallons a minute for days, because the oil was thin and easy to pump," said the *Sedge*'s skipper, Lt. Comdr. George A. Capacci. "That's 16,000 barrels a day, theoretically—if we had had a barge to pump to. As it was, it took us more than two days to deploy the boom, because we never had practiced it. Then the oil got so thick that we couldn't



Breakdown of a spill

As soon as the oil gushed into the cold water of Prince William Sound, it began to change, affected by physical and chemical weathering processes, the initial phases shown above.

The spill spreads and starts to evaporate. Oil droplets disperse into the water column, a generic liquid core sample. Some of the oil's aromatic components dissolve, and the slick grows more viscous.

As waves stir and batter the hydrocarbon bouillabaisse, it forms a heavy water-in-oil emulsion, or mousse, almost impossible for cleanup crews to pump.

In silt-laden water, oil droplets can also join suspended particulates by adsorption and sink. "Despite fears that the sound's bottom would be paved with oil, the particulate concentration was too low. It didn't happen," says marine chemist Dr. James R. Payne.

Weeks later, at right, bacteria (red) attack the surface of the oil, and sun-stimulated oxidation dissolves more components. Eventually wind and waves shear the mousse into pancakes, which in turn break into tar balls that may wash ashore.

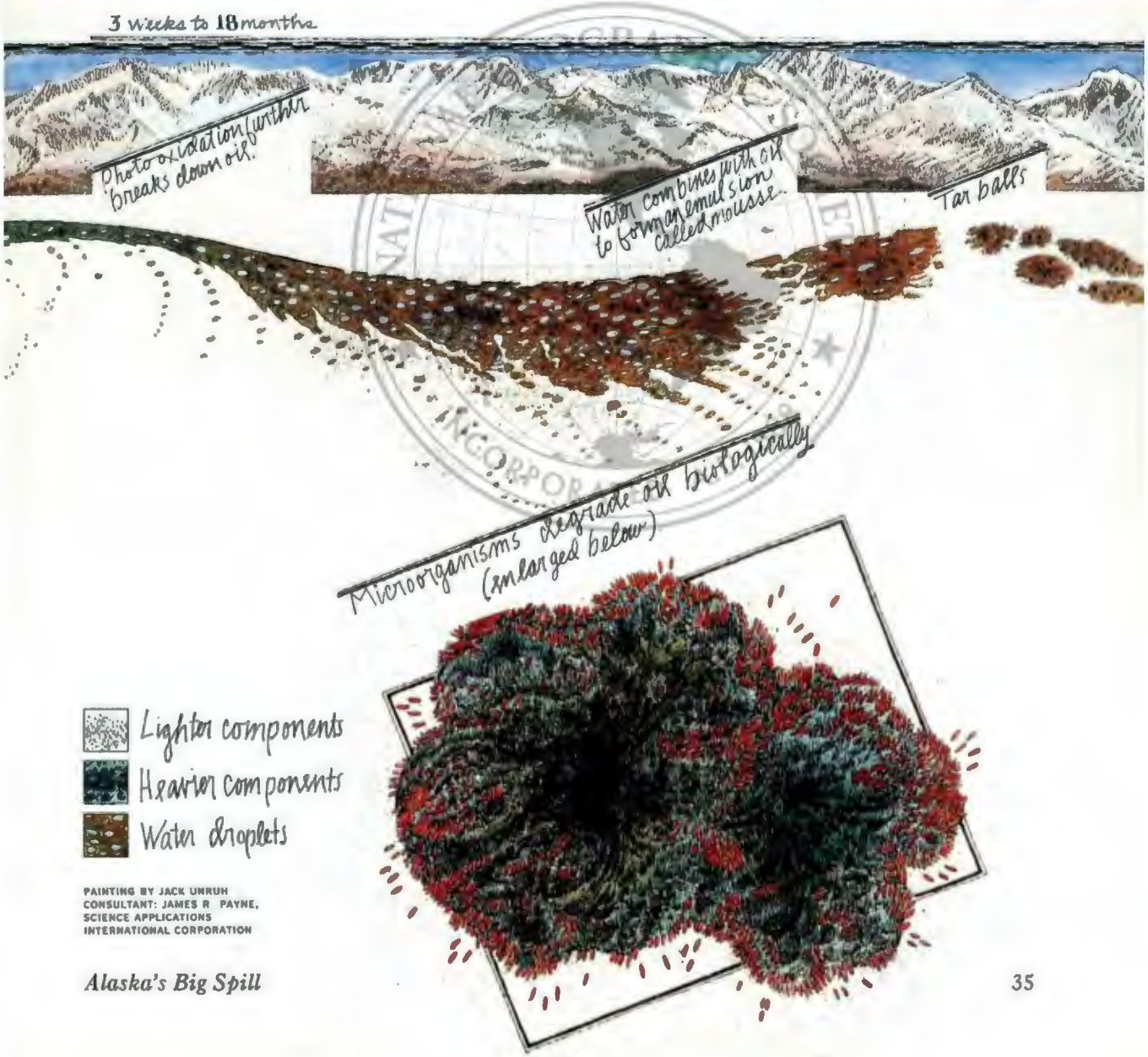
pump it any more. So the total skim for *Sedge* in seven days was about 3,500 barrels."

Such episodes were typical in the spill's first days. NTSB investigators wanted to know why the response team of the Alyeska Pipeline Service Company required 12 hours to mobilize and travel the 28-mile distance to the *Exxon Valdez,* an apparent violation of the five-hour response time specified in the official contingency plan.

There was no violation, protested Lawrence D. Shier, Alyeska's marine manager, since the plan merely described "a set of conditions that cannot really be extrapolated to a real situation." Alyeska was more specific in a written statement subsequently delivered to the board: "Equipment which Alyeska, with the approval of the State of Alaska and the federal government, had assembled for use in response to a 'most likely spill' of 1,000 to 2,000 barrels was now being employed to combat an oil spill approximately 175 times larger."

CONFUSION WAS THE NORM in Valdez in the first days. Decision making was the province of committees that included representatives of eight state and federal agencies. The strongest voices belonged to members of the Cordova District Fishermen United (CDFU), who had won injunctions against construction of the Alaska pipeline. Their battle was lost in 1973 when Congress authorized construction, but Cordovans have had little regard for the oil industry since then—an attitude reinforced by knowledge that today a large red salmon is worth more than a barrel of oil.

"The fishermen were the only ones who knew the tides and currents. And we were the only ones who had boats to do the work," I



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CONSULTANT: JAMES R. PAYNE, SCIENCE APPLICATIONS INTERNATIONAL CORPORATION

was told by Jack Lamb, a CDFU officer. "I told Exxon that the oil posed a real threat to the hatchery at Sawmill Bay, and that we wanted to take all available booms and skimmers to protect it. Exxon said OK. That was the only time there was a large concentration of equipment to save a specific place."

Lamb later won applause at a congressional inquiry after he heard that Alyeska experts had dismissed the possibility of a 200,000-barrel spill as something that might happen once in 241 years.

"There's a saying only one in 100 Alaska brown bears will bite," he said. "Trouble is, they don't come in numerical order."

WHATEVER ALYESKA'S ROLE, it was swallowed up almost immediately by the activities of the Exxon Shipping Company, whose response team arrived in Valdez within 24 hours of the accident.

"We went all the way to the Black Sea of Russia to get large booms—from Russia, from Finland, from Norway, from Denmark, from France, from the United Kingdom. In early stages we were chartering U. S. military aircraft; we needed C-141s and C5-As to move the heavy stuff," Frank Iarossi, Exxon Shipping president, told the NTSB panel. "The one clear thing we were not able to do, and I'm not sure there was a power on earth that could do it, but that was recover the 258,000 barrels that had already spilled. The only thing that could have helped was dispersants."

Just two weeks before the spill Alaska environmental officials had preauthorized emergency use of chemical dispersants, which act like a detergent to break up oil into tiny droplets that mix with water. Final authority rested with Commander McCall, as federal on-scene coordinator. Because the sea was calm, lacking energy to mix dispersants, he wanted tests made. Not until Sunday afternoon did results convince him they would be effective.

By then it was too late. Exxon had amassed 40,000 gallons of dispersant, enough to break up only a fraction of the spill, but 70-knot winds made further spraying impossible.

Later, responding to a state of Alaska civil suit for damages and costs of the spill, Exxon would countersue, charging that the state itself was responsible for some of the damage because it had argued against dispersants—a charge the state vigorously denied.

Meanwhile, the chaotic mess of floating oil became the responsibility of Jim O'Brien, Exxon's water-cleanup coordinator. A retired Coast Guard officer who commanded the Pacific Area Strike Team, he had handled more than a hundred oil spills.

By coincidence we had met only weeks before in Antarctica, where he had been called in by the National Science Foundation for a spill of more than 170,000 gallons of diesel fuel by an Argentine naval transport at Palmer Station. Volatile diesel fuel evaporates rapidly, leaving little residue.

This spill was different. He had assembled a fleet of some 60 skimmers. Most effective were 22 Marco vessels provided by the U. S. Navy. The Marco skimmers use an oil-attracting belt rather than pumps and can handle a wide range of oil thickness.

And thickness was the problem.

"The oil was changing daily," O'Brien said. "The most volatile portion evaporated in the first 20 hours. Then wave action mixed the

FLIP NICKLIN (RIGHT)

Beneath the mousse, diver Mark Dionne (facing page) avoids a mess in Montague Strait ten days after the spill.

Oil will not sink without added weight. By the time the mousse reached Katmai, some had turned to sticky muck that had accumulated enough sediment and detritus to settle in the shallows (above). "It took hours to get the stuff off my diving suit," says photographer Natalie Fobes. Mixed with fine-grained sediments, such deposits may persist for years.

FLIP NICKLIN (ABOVE)

Could multimillion-dollar fisheries disappear from the sound in a cloud of oil? First the May herring season—worth 12.3 million dollars in 1988—was canceled, but the salmon catch brought in six times as much, a bonanza symbolized by their teeming fry (above).

To protect such young salmon, scheduled for release from the Armin F. Koernig Hatchery a month after the spill, a furious campaign to set booms, dubbed the "Battle of Sawmill Bay," left volunteers limp but victorious (right). A pink salmon fry's adipose fin is clipped (bottom right), a signal that its nose contains a coded wire and

that when the adult fish returns two years hence, the head should be sent to officials who will check for toxic effects.

With the spill threatening this year's returning adults, the state announced a zero-tolerance policy for contamination. Chris Allison, a microbiologist, examines a salmon sample with tests that include sight, smell, taste, and fluorescence under ultraviolet light. Of thousands scrutinized, none failed. Although most spill-affected waters were closed, fishermen still caught 24 million salmon in sound waters that remained open, part of a near-record statewide catch of 152 million.

heavier remaining oil with water to create an emulsion, or mousse, that was about 80 percent water. By the time this mixes with kelp and other debris, it is so heavy that pumps can't raise it more than two or three feet.

"There's an important thing people must realize in planning for a spill this size: No amount of equipment will clean it all up, even if they give you a month's notice to get ready," he said. "Look at the expanse of water involved, and figure the time it takes to deploy boats and skimmers and support vessels at 12 knots. Skimmers need barges to collect their oil. Crews need food, ships need fuel, and somebody has to collect the garbage.

"And nothing works if the weather's bad."

In mid-September, weather in the Gulf of Alaska can go from sunshine to blizzards with very little warning. And so, for better or worse, the massive mechanical cleanup program wound down.

BUT AT SNUG HARBOR, on Knight Island, I find that a very subtle but very exciting cleanup program has just begun. Scientists of the Environmental Protection Agency have successfully demonstrated a process called bioremediation, in which oil-eating bacteria, native to Prince William Sound, may become the best cleanup crew of all.

Chuck Costa, EPA's site manager, shows me a long pebble beach neatly marked off into test plots by staked cords.

"We sprayed some plots with a special fertilizer called Inipol EAP22. Other plots we left alone. The fertilizer stimulated the bacteria to degrade the oil faster and began making a dramatic difference in the appearance of the rocks in only two to three weeks."

He turns some rocks over, and I see they are clean underneath. Only by digging about five inches into the shingle can I find evidence of the oil that once coated the entire beach. Sand fleas leap about my hand as I dig.

"We are still learning how deep the bacterial activity may go," Costa says. "We believe it may extend as deep as 12 inches in some areas. What the bacteria leave behind are the asphalt hydrocarbons. They are unsightly, but they aren't toxic."

One of the project's originators was Dr. Hap Pritchard, chief of EPA's Microbial Ecology and Biotechnology Branch at Gulf Breeze, Florida. When the spill occurred, he was

They have met the enemy, and it's all over them. A dog-tired crew that has done battle on Eleanor Island rides a landing craft to the U.S.S. *Juneau*, an assault ship chartered to feed and house about 400 workers. Weekly paychecks during the

cleanup averaged $1,800, yet the risks of exposure to oil for days at a time, despite protective clothing, are virtually unknown. Ironically, more has been learned of oil's toxic effects on animals than on the people who tried to save them.

working on a new EPA program to develop bacterial degradation of toxic waste.

"Stimulation of bacterial growth by nitrogen and phosphate feeding is well-known, but never on large-scale spills," Dr. Pritchard told me. "The idea of an oleophilic fertilizer—one that will cling to oiled surfaces—came from the French company Elf Aquitane. The fertilizer liquid contains oleic acid, lauryl phosphate (a shampoo-like detergent), and urea. We have tested it for toxicity to marine organisms and found it to be perfectly safe when applied properly."

Some environmentalists protested the technique, saying it could cause a plankton bloom. The state required further testing on Alaska organisms, and only six weeks after the successful demonstration was Exxon given permission to spray the fertilizer on 70 miles of beaches that had been heavily contaminated.

One of them was on Green Island, which I had visited months earlier to see the massive cleanup operation in full swing.

Now the beach was silent. There were still signs of oil but not the sticky black enamel-like coating that had been left after the first assault. I saw mussels and barnacles and seaweed growing in crevices of the rocks.

Perhaps it is true, I thought, that such catastrophes as the great Alaska oil spill are beyond man's ability to remedy. But are they within man's ability to prevent?

Congress has attempted to answer that question with stringent legislation requiring elaborate inspection and control of tanker operations and crew training. The oil industry has proposed a 250-million-dollar program to establish five coastal response centers, each equipped to deal with a spill of 8.4 million gallons. Meanwhile, debate continues on the merits of requiring tankers to have double hulls. Research into larger and more efficient oil pickup systems has been reactivated.

But nobody I talked to believed that technology alone could control giant spills, even in favorable weather and favorable locations. Sooner or later, through human error or simply through the perils of the sea, spilled oil will assault another shore. And sooner or later, the damage will have to be left to nature to repair.

But never again should nature be left so foolishly to chance. □

On January 28 an EXPLORER TV program covering the potential impact of oil development on Alaska wildlife will air on TBS SuperStation at 9 p.m. eastern time.

Like a vividly multiplying malignancy, the spill returns to Valdez in the form of thousands of bags of oily cleanup debris. Clean-burning hospital incinerators processed this batch, which required about six months. Recovered oil was recycled, and 50,000 tons of additional oil-soaked material were shipped to an Oregon toxic-waste dump.

In June oily water oozes up from contaminated sediment to fill a hole dug on a Block Island shoreline previously treated by Exxon. The company disbanded its cleanup army in mid-September pending the arrival of winter storms, which some experts believe will become natural allies by continuing to remove the oil. Meanwhile, ice and snow may keep this Alaska tragedy out of sight, but not out of mind.