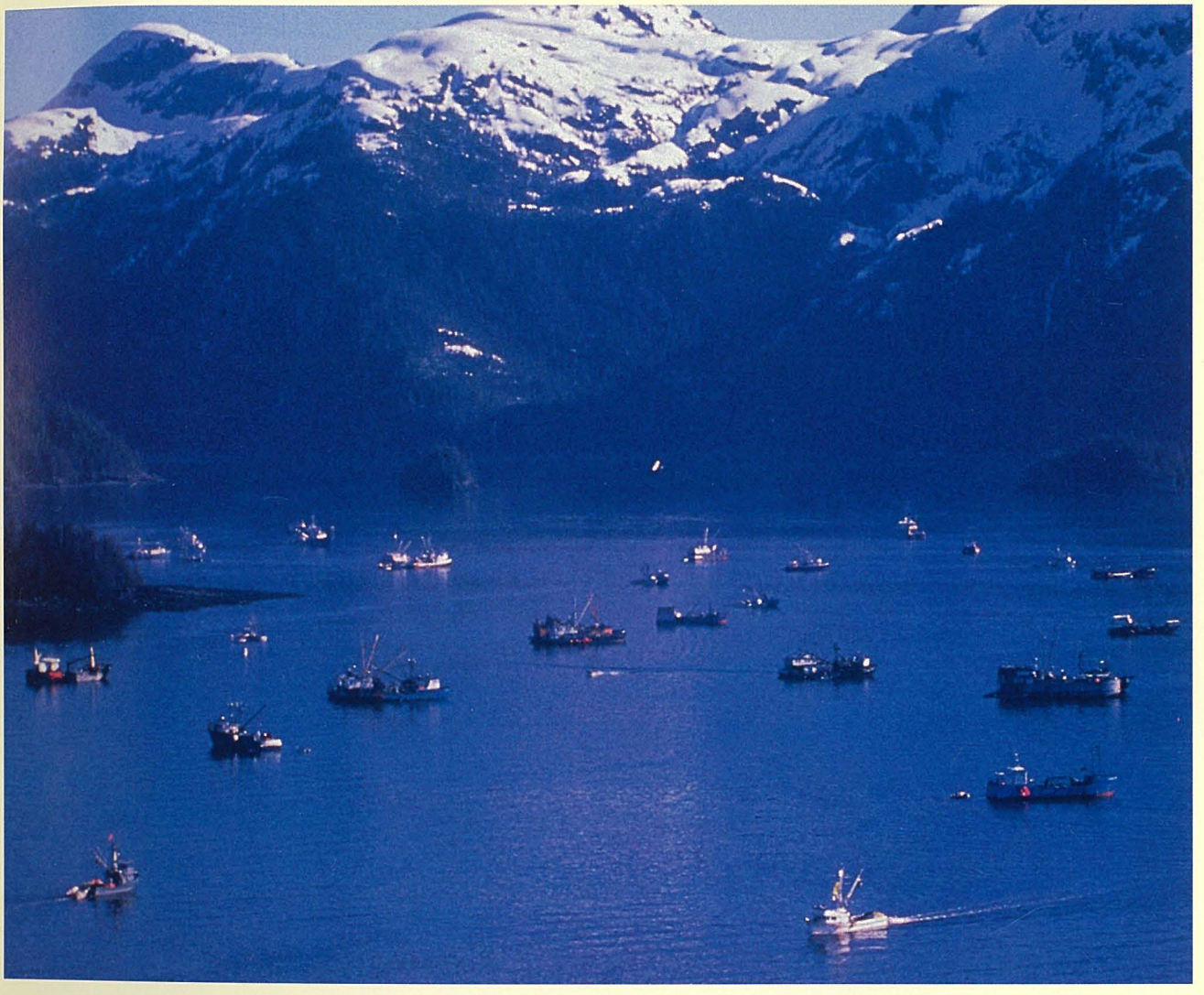
Alaskan Fisheries

Two Years After the Spill



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February 1991

PREFACE

This background paper responds to concerns that the 1989 *Exxon Valdez* spill might have damaged Alaska's fisheries, which are vital to the area's economy and lifestyle. It describes the robust condition of Prince William Sound fisheries and future prospects for seafood harvesting in Alaska. It does not include results of any of the research that has been conducted in Prince William Sound since the spill, but relies on the 1989 and 1990 commercial fishing results, the thousands of previously published scientific studies of oil in the sea, and the history of fishing after major spills in other regions.

The four authors all have extensive experience with Alaska's fisheries:

William F. Royce, Ph.D., Professor Emeritus of Fisheries in the College of Ocean and Fishery Sciences of the University of Washington in Seattle and retired executive of the U.S. National Marine Fisheries Service. For many years, he has studied fisheries management and the fish species of Alaska.

Thomas R. Schroeder, a fisheries consultant based in Homer, Alaska. He recently retired from the Alaska Department of Fish and Game, where he served as commercial fisheries management biologist for part of the area affected by the oil spill.

A.A. "Ole" Olsen, an Anchorage fisheries consultant and former fisherman, bush pilot and manager of seafood-processing plants throughout Alaska. In 1989 and 1990, he reviewed results of scientific studies (which he helped conduct) of the area's fish stocks with Alaskan villagers who rely on fish for subsistence. In addition, he participated in 1990 fishery-related spill cleanup activities.

William J. Allender, a former commercial fisherman and owner/operator of a sport fishing business based in Cordova Harbor in Prince William Sound. In 1989, he participated in Exxon's wildlife rescue programs. In 1990, as a consultant to Exxon, he worked with the Alaska Department of Fish and Game to help ensure the safe operation of Prince William Sound fisheries.

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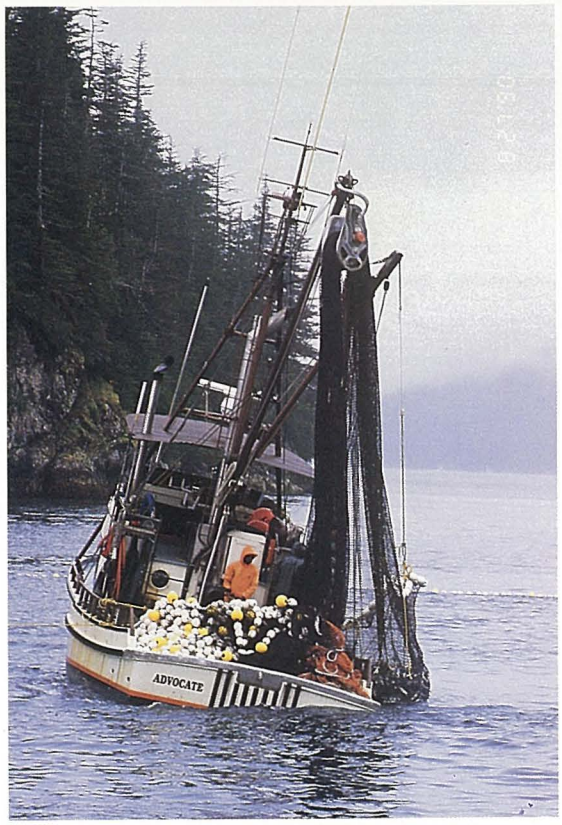


In 1990, fishermen caught 44.2 million pink salmon in Prince William Sound, far eclipsing the previous record of 29.2 million fish.

1

SUMMARY AND CONCLUSIONS

In March 1989, the tanker *Exxon Valdez* struck a submerged reef off Bligh Island in Alaska's Prince William Sound, spilling about 11 million gallons of North Slope crude oil onto the waters. As the slick spread, anxiety also spread among the local commercial and sport fishing industries. Many fishermen worried whether the spill had ruined their livelihoods forever.

Within a year and a half, however, the commercial and sport fishing industries could move beyond the pessimism following the spill. During the 1990 season, commercial fishermen in Prince William Sound enjoyed record-breaking catches. In April, purse seiners netted 8,300 tons of herring — more than the entire year's "harvest quota" — in just 20 minutes, though the season typically lasts several hours. Then, over the summer, fishermen caught 44.2 million pink salmon, far eclipsing the previous record of 29.2 million fish.

The ample stocks of herring and pink salmon were significant to the sport and commercial fishermen for several reasons. Economically, the area's fishermen have traditionally harvested both pinks and herring in large numbers, and they rely on them for a major portion of their income. Biologically, the two species are considered more vulnerable to adverse effects of the oil than other species. The record-breaking harvests therefore have positive implications for less vulnerable species, including such favorites as halibut and king and coho salmon.

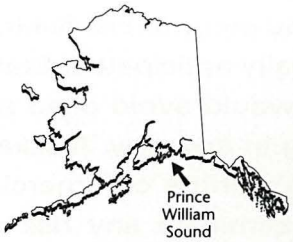
In spite of the accident, the sport and commercial fishing industries fared better in 1989 than originally anticipated. State officials concluded that sport fishermen would avoid oiled areas, and they did not restrict sport fishing in any way. Alaskan officials did close many of the spill area's prime commercial fisheries following the spill in order to eliminate any risk of marketing fish contaminated by oil-fouled nets or other gear. Although this action did force many fishermen to abandon their traditional fishing grounds, the total 1989 pink salmon harvest in Prince William Sound was still the fourth highest on record,

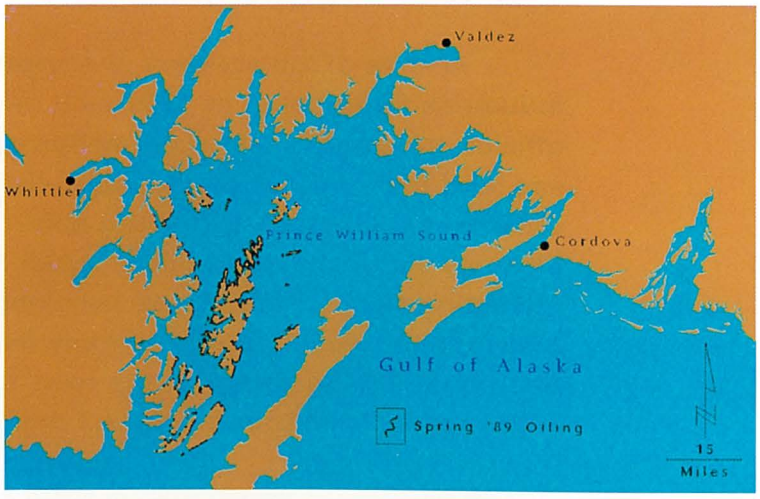
bringing in 21.9 million fish worth an estimated $33.3 million. Statewide, commercial fishery production totaled $1.3 billion, the second largest ever.

The area's commercial fishermen received financial compensation based on losses resulting from the various 1989 fishery closures. As of year-end 1990, Exxon had paid $169 million to local fishermen in response to 1989 claims, and another $133 million had been committed to seafood processors and related industries.

Many of the local fishermen assisted with the oil spill cleanup during the two summers following the accident. Because of their knowledge of the remote area, the fishermen proved invaluable to Exxon's cleanup operations and wildlife-rescue programs. Exxon paid more than $105 million in wages and chartering fees to 1,440 individuals and firms that also received compensation for damages. This group includes 1,160 local commercial fishermen.

The potential long-term impact of the oil spill on fish is under careful study, but it is unlikely that any significant adverse effects on finfish populations will be discovered. Throughout 1989 and 1990, there were no confirmed reports of large fish mortalities, oil tainting, or contamination of commercial seafood products from the spill. In addition, long-term damage to finfish has not been documented in the hundreds of studies of earlier oil spills — many of which were larger than the *Exxon Valdez* spill.





Oil from the spill reached less than 20% of the Prince William Sound shoreline.

2

IMPACT OF THE SPILL

Prince William Sound and the Gulf of Alaska constitute an enormous area, nearly 9,000 miles of coastline. Surveys showed that oil from the 1989 spill reached less than 20% of the Prince William Sound shoreline, and a small percentage of the Kenai peninsula, Kodiak Island, and Alaska peninsula shorelines. It spread into the western portions of the Sound and about 500 miles west to the Alaska peninsula and Kodiak Island (Maki, 1991).

Impact of the Spill on Water Quality

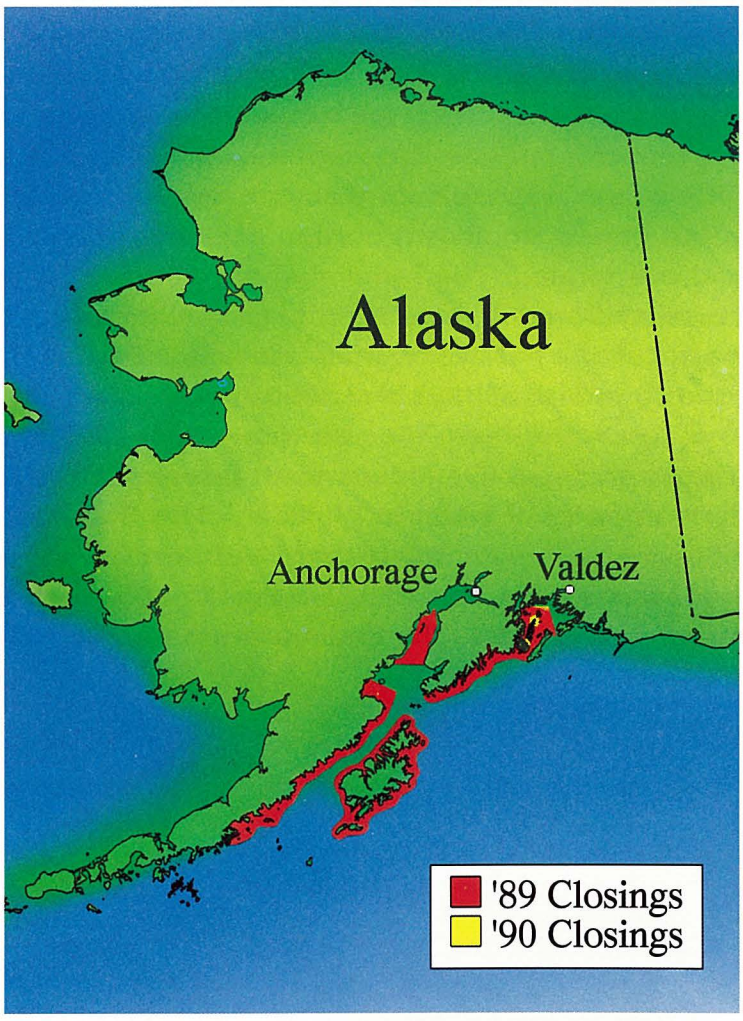
About one-third of North Slope crude oil consists of volatile hydrocarbons, which are relatively toxic, but almost all of them evaporate into the atmosphere within a few days (Galt, 1991). Three days elapsed before any oil reached the shoreline, and by that time a significant portion of the volatile hydrocarbons had evaporated. The remaining two-thirds of the North Slope crude oil is predominately composed of less toxic materials — the object of the massive cleanup operations Exxon mobilized during the summers of 1989 and 1990.

Exxon engaged five independent research organizations to study the quality of water in Prince William Sound immediately following the spill. More than 2,300 samples were taken from 61 locations from March to October of 1989, including the most heavily oiled areas. The findings were published in 1990

Today, the waters and shorelines of Prince William Sound and the Gulf of Alaska have been essentially cleansed of oil from the 1989 spill.

by Dr. Jerry M. Neff, senior research leader of Battelle Ocean Sciences, Duxbury, Massachusetts. His summation:

> *Fish kills have been reported after some oil spills, though it is important to note that there have been no verified reports of fish kills in Prince William Sound attributable to the oil spill...*
>
> *Based on these observations from other spills, it is unlikely that there were effects of the oil spill on fishery species in Prince William Sound. Any effects would have*



Portions of five (marked in red) of the state's 15 fishery management areas were closed at some point during 1989. By 1990, only two small areas (marked in yellow) in Prince William Sound had closings.

occurred in the few weeks immediately after the spill and would have been very localized and minor relative to fishery stock sizes and future catches. It is unlikely that any long-term effects directly attributable to the spill will be observed in terms of reduction in reproduction and early survival of fisheries species or in decreased fishery catch of any commercial species...

In most cases, the [hydrocarbon] concentrations measured in the Sound were at least 1000-fold lower than concentrations that are harmful to fish. Thus, the margin of safety for fish in Prince William Sound is very large and has grown larger as the concentrations of petroleum hydrocarbons in the water column have decreased over the summer and fall of 1989.

After two summers of cleanup and two winters of harsh storms and powerful waves, the waters and beaches of Prince William Sound were essentially clean at the end of 1990. Except for a few scattered sections with weathered residue, shoreline survey teams with representatives from the U.S. Coast Guard, Alaska's Department of Environmental Conservation, and Exxon did not find oil in August 1990.

Impact of the Spill on the 1989 Fisheries

In 1989, the Alaska Department of Fish and Game closed several commercial fisheries in order to prevent fish contaminated by oiled gear from reaching the consumer. The department

Prince William Sound's purse seiners netted 8,300 tons of herring — more than the entire year's harvest quota — in just twenty minutes, though the season typically lasts several hours. The State of Alaska's pre-season projected harvest was 6,300 tons of fish.

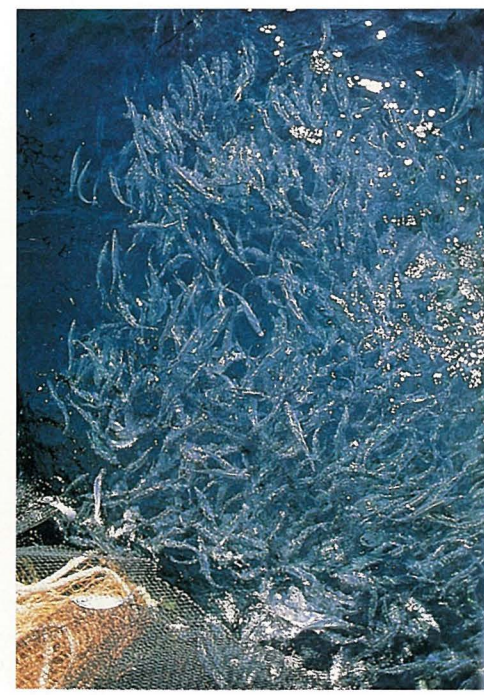
closed portions of five of the state's 15 fishery management areas (Savikko, 1990).

But, even with some areas closed to fishing in 1989, the statewide seafood harvest reached 5.2 billion pounds, with a value of $1.3 billion — the second highest value at that time (Savikko, 1990). The 1989 Alaska harvest represented 38% of the total revenues from all United States commercial fisheries (USNMFS, 1990).

Immediately after the spill, Exxon and local fishermen gave the highest priority to protecting the salmon hatcheries, four of which are located in the spill area. Protective booms were placed around the hatcheries, and all of them remained totally free of oil. In Prince William Sound, protection of the hatcheries was considered especially vital to survival of the salmon fishery, which depends on hatchery-reared pink salmon fry for over 80% of the catch (ADF&G, 1990).

Impact of the Spill on the 1990 Fisheries

In 1990, as cleanup operations continued on isolated beaches, the fisheries operated normally in Prince William Sound and the Gulf of Alaska. Only two small areas were placed off-limits for the season; these were not prime commercial or recreational fishing areas, and there were no reports of fouled gear or contaminated fish attributable to the 1989 spill (ADF&G, 1990).



Although final figures are not yet available, preliminary Department of Fish and Game reports indicate that the statewide 1990 salmon catch may surpass the 1989 totals, partly because of extraordinary returns in Prince William Sound (Savikko, 1990).

3

SALMON AND HERRING: THE LITMUS TESTS

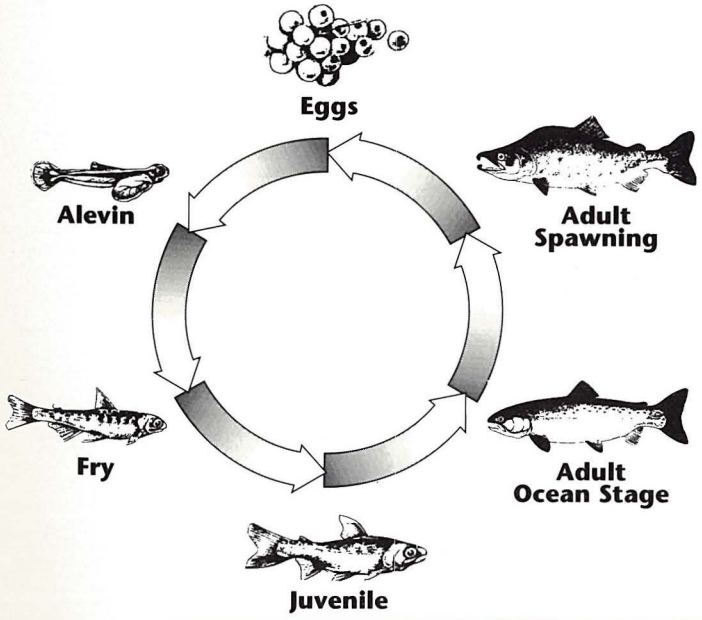
Two major Alaskan fisheries — pink salmon and herring "sac-roe" — warrant special attention because these species have traditionally been harvested in large numbers within Prince William Sound and because the spawning herring and the young of both pink salmon and herring were especially vulnerable to the oil spill.

Pink Salmon

Salmon species constitute a vital element of Alaska's economy and lifestyle. Salmon harvests provide the main source of revenue for the state's commercial fishing industry, the prime target of sport fishermen, and a basic component in the subsistence diet of many villagers.

Pink salmon, the most abundant Pacific salmon species, have a relatively simple two-year life cycle (see illustration), distinct from other salmon species. These fish are spawned in freshwater intertidal areas or streams. As fry, young salmon move into marine intertidal areas to feed before they head for open seas to mature as adults. After approximately one year at sea they return to their native streams to spawn and die.

Two-Year Life Cycle of Pink Salmon

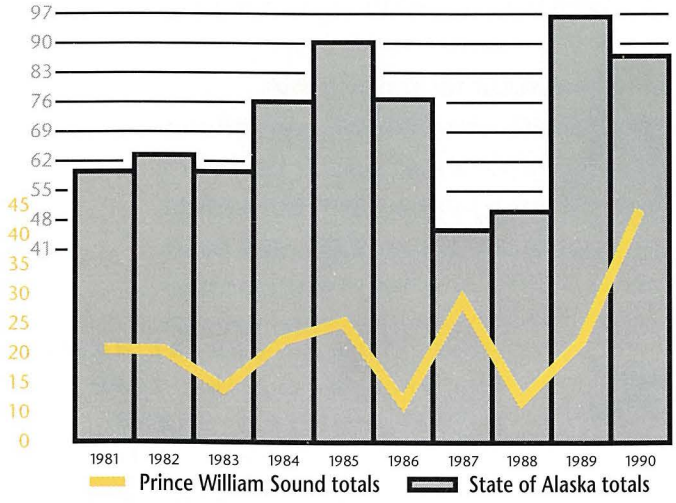


Pink salmon caught during the record-setting 1990 Prince William Sound harvest had been vulnerable fry heading to sea shortly after the oil spill.

The adult pink salmon harvested in August 1990 had emerged as fry into the intertidal areas of the Sound and Gulf of Alaska in April and May of 1989. They were heading to sea within a few weeks of the oil spill at a particularly vulnerable time in their life cycle when they would grow from about one-and-a-half inches to about three inches in length. Young pink salmon tend to remain close to shore during their first summer and move into deeper coastal waters in September (Hart, 1973). This migration pattern near the path of the spilled oil raised questions about the oil's possible effect on them.

Even under normal conditions, many unpredictable factors impact the survival rate of young fish, including weather conditions, predators, and the availability of food. The harvest of pink salmon is also subject to annual fluctuations.

In 1989, many commercial fishermen seeking pink salmon had to abandon their traditional grounds and seek waters that had not been closed by Alaska's Department of Fish and Game. As pink salmon swam out of the oiled areas, fishermen were able to catch them as they moved from closed to open areas. Despite the closings, 1989's total harvest in the Sound was 21.9 million pink salmon, with a value of $33.3 million (Brady, 1990). It is the fourth largest pink salmon harvest on record and compares to 11.8 million fish in 1988 and 29.2 million fish in 1987 (Brady, 1990).



Commercial Pink Salmon Harvests (in millions of fish)

Fluctuations mark pink salmon catch totals in Prince William Sound and Alaska over the last ten years.

The statewide catch in 1989 totaled 96.5 million pink salmon, a record (see chart p. 10). Fishermen in 1989 received prices within the normal range for the decade (Savikko, 1990).

In establishing the catch limits for all salmon stocks, the state Department of Fish and Game attempts to allow an optimum number of fish to escape for spawning purposes. In 1989, because of the fishing limitations, state biologists estimated that in some streams more than the usual number of pink salmon escaped the fishing nets and went on to spawn. These larger "escapements" may be beneficial to those streams that have been depleted of breeding stock, many of which are in Prince William Sound, but a surplus could be wasteful in other streams. The impact of the 1989 escapement will not be known, however, until the pink salmon harvest of 1991 is completed.

By the time the 1990 salmon arrived, the state had removed restrictions on fishing in the spill-affected region, with two minor exceptions. Statewide, 87 million pink salmon with an average value of about $1 each were caught (Engstrom, 1990). Prince William Sound accounted for 51% of the total with a catch of 44.2 million fish, breaking the 1987 record of 29.2 million fish (Brady, 1990). The average fish size was somewhat smaller than normal, 3.0 pounds versus a ten-year average of 3.5 pounds, which may be due to competition for food or to other marine habitat changes at sea.

In 1990, catches in the Lower Cook Inlet were about half the long-term historical average (Bucher, 1990). In the Kodiak management area, catches were below expectations (ADF&G, 1990). One possible factor influencing these results was a lower-than-expected return from the Tutka and Kitoi Bay hatcheries, neither of which was affected by the oil spill. Both of these low returns are not inconsistent with past harvests from these hatcheries. For example, the total Kitoi catch ranged from 301,000 fish in 1982 to 6,771,000 fish in 1989. Another factor was the closing of one district to salmon fishing for sockeye stock-management purposes, thus allowing a large number of pink salmon to escape the fishermen's nets.

State biologist James Brady called the 1990 pink salmon catch in Prince William Sound "a pleasant surprise." He credited

the catch to exceptional 1989 weather coupled with a plentiful plankton bloom to feed the young salmon (Villeneuve, 1990). Most significantly, the 1990 pink salmon catch should alleviate fears that the Alaska salmon fishery has been harmed by the spill.

Implications for Other Salmon

In addition to the pink (humpback) salmon, four other species of salmon are harvested commercially in Prince William Sound and the Gulf of Alaska — chinook (king), sockeye (red), coho (silver), and chum (dog). Because the harvest for pink salmon — the most vulnerable species — was bountiful, we are optimistic that the other salmon fisheries were likewise unharmed.

Oil did not threaten the spawning and rearing areas of the sockeye, chinook and coho salmon because they are located in freshwater lakes and streams far from the spill area. Unlike pinks, these species mature for one, two and sometimes three years in these areas before heading for the ocean. For example, the commercially important sockeye or red salmon is four or five inches long when it heads to sea as a one- or two-year old — much larger, older and stronger than the tiny pinks that head for salt water. If the spill did not harm the pink salmon fry of 1989, the larger sockeye juveniles were even more likely to survive. King and coho juveniles are even larger when they head to sea, averaging between five and seven inches in length (Hart, 1973).

In spite of the oil spill, the state of Alaska experienced a record salmon harvest in 1989, a catch of more than 153.3 million fish (Savikko, 1990). The 1990 statewide salmon catch was not affected by the oil spill and is expected to top 1989's total harvest after all the statistics are compiled. The preliminary 1990 catch figures include about 650,000 chinook, more than 52 million sockeye, 5.2 million coho, and more than 7.5 million chum salmon (ADF&G, 1990).

The statewide salmon harvest has increased significantly during the past decade because of improved management techniques, development of hatcheries, and favorable weather.

The catches of 1989 and 1990 — especially the 1990 pink salmon run in Prince William Sound — suggest that this favorable trend has not been affected by the oil spill.

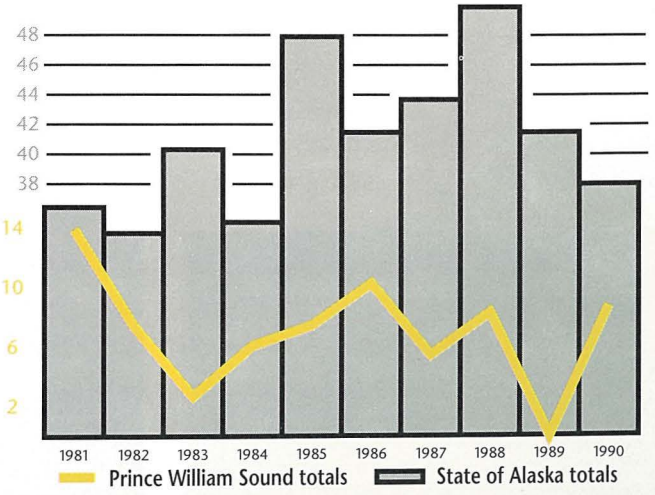
Pacific Herring

The Pacific herring is important to the Alaska fishing industry because its eggs or roe are sold in large quantities to the Japanese market and because, as part of the food chain, it is consumed by larger commercial species of fish such as salmon and halibut.

Herring are mass spawners and congregate in shallow areas (depths less than 35 feet) where eelgrass, kelp and other seaweeds can be found. From April to June, females deposit eggs. The eggs, which are sticky, adhere to underwater plants, rocks and other surfaces where they are fertilized by the males (Hart, 1973). Since herring spawn in such places, there was potential in 1989 for spawning fish or their eggs to become exposed to spilled oil.

The annual harvest draws from herring within a five-year age span. Thus, each year's catch is not dependent on a single year's successful survival, as with pink salmon.

In Alaska, there are four commercial herring fisheries. First, a small number of fish are caught for food and bait. Second, divers gather herring eggs or roe on kelp in shallow, open waters.



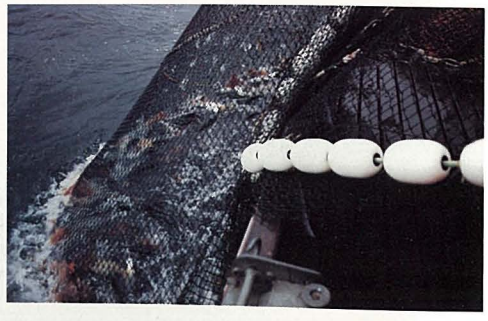
Commercial Sac-Roe Herring Harvests (in thousands of tons)

Herring sac-roe harvests fluctuate from year to year.

Third, roe is gathered on kelp in man-made enclosures (this is known as the pound-kelp fishery). The fourth and most important commercial harvest is the "sac-roe" fishery, in which herring are netted to collect the mature female's egg-filled membrane or sac. Each year the state limits the sac-roe harvest to 20% of the estimated herring stocks.

In 1989, the state closed Prince William Sound to the sac-roe herring harvest, which usually takes place in April. Nevertheless, the statewide sac-roe harvest was 41,387 tons with a market value of $16.3 million — compared to 49,766 tons in 1988 (Savikko, 1990).

Most of the herring that spawned in Prince William Sound in 1989 were available to fishermen in 1990, since herring, unlike salmon, do not die after they reproduce. They continue to reproduce until they are nine years old or older. The bulk of herring harvested in Prince William Sound are three to seven years old. The 1989 crop of eggs will start returning as harvestable three-year-olds in 1992. Based on current population estimates by the Alaska Department of Fish and Game, prospects are encouraging for future herring harvests.



Prince William Sound was reopened to sac-roe fishing in April 1990, and the herring were so plentiful that fishermen netted 8,300 tons in 20 minutes, a harvest 32% higher than the pre-season projection of 6,300 tons (Brady, 1990; Savikko, 1990). That catch represented 22% of the statewide total harvest of 37,866 tons.

The successful Prince William Sound 1990 sac-roe harvest indicates that the herring population is thriving. Many of the fish caught in 1990 were spawning in Prince William Sound at the time of the oil spill.

Alaska's Department of Fish and Game has also recently measured a huge mass of herring in the Sound and is projecting a large harvest in 1991 (Brady, *et al.*, 1990). The healthy state of the herring fishery is not only significant from the standpoint of the oil spill, but it also shows that there will be a plentiful supply of herring as food for salmon, other large species of finfish, marine mammals, and waterfowl.

Prince William Sound's pink salmon harvest was a record in 1990, even though most of these two-year old adults had traveled through the Sound's waters as vulnerable fry in the months following the spill.

This youngster and other Alaskan villagers subsist on the area's fish stocks.

4

OTHER FISHERIES IN ALASKA

In addition to commercial harvests, there are two other important fisheries in Alaska — subsistence/personal-use harvesting and sport fishing. In contrast to the numerous 1989 commercial fishery closings, only one area had restricted subsistence fishing, and there were no restrictions on sport fishing. Government officials announced that the salmon and other finfish throughout the area were safe to eat.

Subsistence/Personal-Use Fishing

When the oil spill occurred, some 2,500 rural Alaskans feared that two of their food resources, fish and shellfish, were endangered (Fall, 1990). To assess the healthfulness of the subsistence seafood resources, joint scientific studies were undertaken by the National Oceanic and Atmospheric Administration (NOAA), the Alaska Department of Fish and Game (ADF&G), and Exxon. Fish and shellfish specimens for these studies were gathered from the most important subsistence resource areas, which were selected by representatives from the rural villages. These village leaders often accompanied the scientists collecting the samples. The State of Alaska and NOAA conducted all chemical or taste and smell tests on more than 900 halibut, 5,000 other finfish, and 300 shellfish samples collected for both subsistence and commercial food safety studies (ADHSS, 1989).

The tests showed that all finfish were safe to eat. Additional tests showed that the hydrocarbon content of smoked fish was substantially higher than the hydrocarbon content of seafood tested in Alaska following the 1989 spill. Some clams and mussels from a few areas with especially heavy concentrations of oil had elevated hydrocarbon levels, although several had been contaminated by refined petroleum products (*e.g.*, diesel fuel) from other sources, not by the 1989 spilled crude oil (Oil Spill Health Task Force, 1990).

Clams and mussels do not constitute a major part of the subsistence diet. Most Alaskans were already cautious about eating these seafoods because of the threat of paralytic shellfish poisoning caused by microorganisms known as "red tide."

Dr. Tom Nighswander, Director of the Alaska Native Health Service, founded the Oil Spill Health Task Force with members including the following organizations:

Alaska Department of Environmental Conservation
ADF&G
Alaska Department of Health and Social Services
Alaska Governor's Office
Exxon
Indian Health Service
Kodiak Area Native Association
NOAA
North Pacific Rim

On the task force's behalf, Dr. Nighswander asked the U.S. Food and Drug Administration (FDA) to conduct a complete food safety assessment based on the results of the NOAA/ ADF&G tests. The FDA concluded that all the fish and shellfish, including those taken from the most heavily impacted areas studied, were safe for a lifetime of subsistence consumption (Quantitative Risk Assessment Committee, 1990).

Task force representatives traveled to the subsistence villages and advised residents: "The best tests to determine the safety of subsistence foods are performed by those who gather the food. If the resources smell or taste of petroleum, they should not be eaten. If they appear clean by these methods, they are almost certainly safe to eat."

Shellfish/Bottomfish

The findings for subsistence fisheries hold positive implications for the area's shellfish and bottomfish fisheries. Unfortunately, the commercial harvest of shrimp and crab in the Prince William Sound area had already ground to a near-halt because the stocks had been depleted by overfishing and consumption by sea otters (Savikko, 1990). Most of Alaska's crab are taken in the Bering Sea, far away from the spill area.

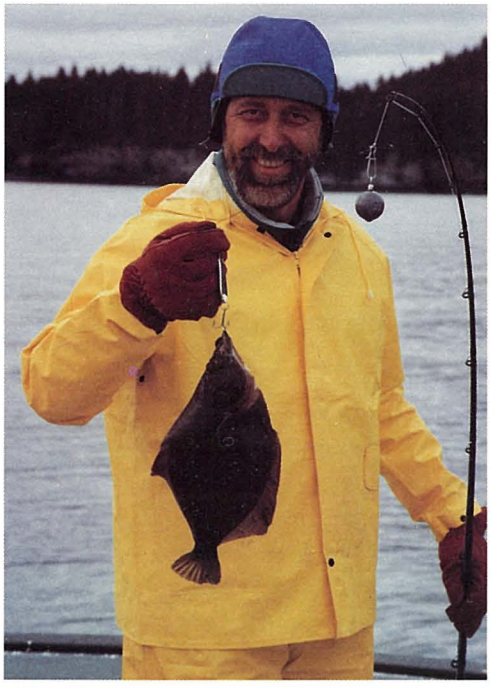
Likewise, the state's prime bottomfish areas are located far outside the reach of the spill, most of them beyond the three-mile limit of the state's jurisdiction. Alaska bottomfish,

which feed on the ocean floor, include halibut, pollock, cod and flounder.

Shortly after the spill, the state closed the waters of Prince William Sound and the outer Kenai peninsula to the harvesting of bottomfish. The areas were reopened to bottomfishing in July 1989. By this time, however, boats normally seeking these fish were either working on the cleanup operation or had shifted to other fisheries. There were no restrictions on halibut fishing in 1989, and the Alaska harvest was greater than it had been the previous year.

Sport Fisheries

Sport fishing for halibut, several varieties of salmon, char (Dolly Varden), cutthroat and lake trout, crab and shrimp provides Alaska with a significant share of its tourist and recreation income from May through September. It is a significant source of recreational enjoyment both for Alaska residents and for visitors from throughout the world. Salmon is the main lure, and the latest attraction is fly-fishing for sockeyes. The state is undertaking special programs to increase fish runs attractive to sportsmen, and it advertises that the Kenai River has the world's largest king salmon and that 450-pound halibut can only be caught off the Alaska coast.



Sport fishermen continued catching and eating fish in the wake of the spill.

The cold-climate wilderness mystique is attracting tourists to Alaska in ever-increasing numbers from all corners of the world. There has been significant improvement in access to

Alaska's fishing centers, and charter-boat touring is a thriving business in such ports as Cordova, Valdez and Whittier in Prince William Sound, and in Homer and Seward on the Kenai peninsula.

Statewide sport fishing rules apply to catch and possession limits, and waters are not normally opened or closed by regional officials on short notice. In the wake of the spill, the state's policies toward commercial and sport fishing were markedly different. While most of Prince William Sound was closed to commercial fishing boats in 1989, there was no prohibition on sport fishing in the same waters. In fact, according to the ADF&G, sport fishing activity in Prince William Sound set a new record in 1989. Activity was 71% higher than the average for the previous ten years (Whitmore, 1991).

State officials kept Prince William Sound open to recreational fishing in 1989 and 1990.

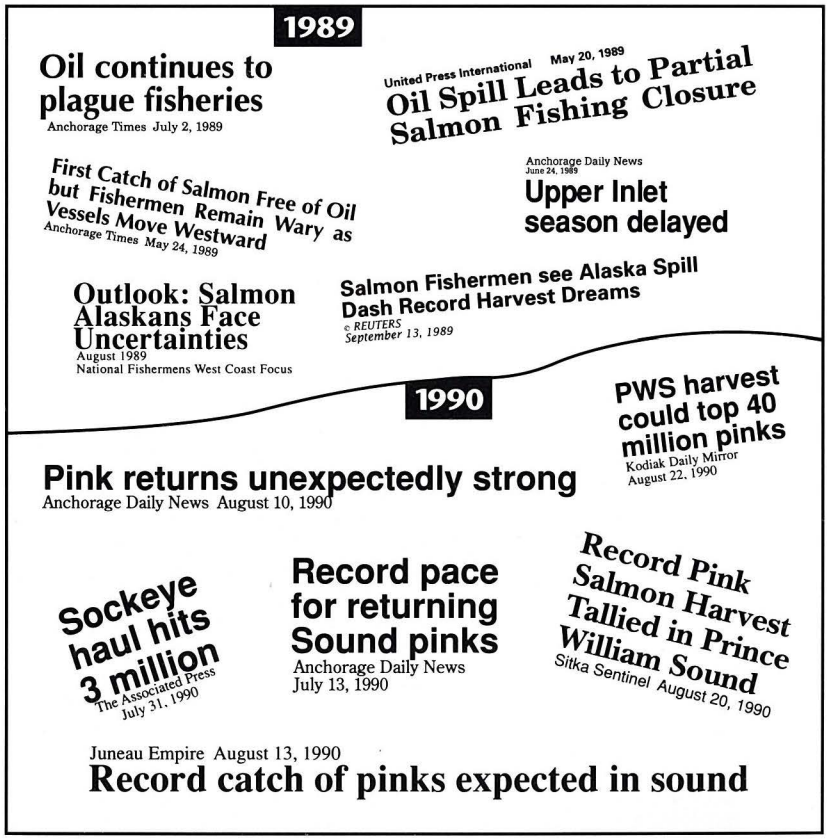
5

SCIENTIFIC INFORMATION

FROM EARLIER OIL SPILLS

Based on extensive scientific studies of previous oil spills, such as those reported by the National Research Council of the U.S. National Academy of Sciences in *Oil in the Sea: Inputs, Fates and Effects*, no one should have been surprised by the successful 1989 and 1990 fish harvests in Prince William Sound and the rest of Alaska.

Other scientific literature that has been developed on the effect of oil in the oceans of the world also supports the National Research Council conclusions. The literature includes a 1990 review of scientific knowledge by the Congressional Research Service of the Library of Congress, a 1982 publication by the Royal Society, and a 1990 compilation of literature on the subject by four United Kingdom oil-spill specialists, *Natural Recovery of Cold Water Marine Environments After an Oil Spill.*



1989's dismal expectations contrast with 1990's headlines.

These publications identify more than 2,000 scientific papers that have been written on the subject. The conclusions:

For species of shellfish, finfish and waterfowl that are harvested, the mortality from an oil spill, so far as is known, has never come close to approaching the magnitude of the annual harvests (Mielke, 1990).

The most significant commercial impact of oil pollution is tainting of the catch, or fear that the catch may be tainted, but natural population fluctuations, or the effects of commercial fishing practices, or the insensitivity of the estimates of recruitment and stock size, mask any impact that losses from oil pollution may have (Clark, 1982).

Massive fish kills during oil spills probably have not occurred. Some mortalities have been observed at a number of spills, but generally only in limited areas, and then not in large amounts. Fish have the ability to move away from an impacted area, either laterally or by moving to a greater depth (National Research Council, 1985).

Annual recruitment of fish stocks fluctuates naturally, and the size of the catchable stocks is determined more by the activities of the fishing industry (e.g. *overfishing) and by climatic changes than by any other factor* (Baker, *et al.,* 1990).

Finfish appear to have the capacity to detect chemical substances and avoid those that might be harmful. Scientists also point out that natural losses of eggs and larvae are normally so huge that losses, if any, caused by an oil spill would not be detectable.

In previous spills, kills of mobile adult fish have rarely been recorded. In 1978, the *Amoco Cadiz* spilled more than 70 million gallons of crude oil — six times the amount spilled by the *Exxon Valdez* — off France's Brittany Coast, and the only significant mortality was of fish that were trapped in the rocky, intertidal waters. Following the 1969 offshore oil rig blowout in California's Santa Barbara Channel, professional spotters observed the fish habitat from the air and recorded no heavy mortality of fish. Studies of numerous spills show that shellfish in shallow-water or intertidal sediments can be the most significant casualities of an oil spill (Baker, *et al.*, 1990).

Oil is not an unusual element in the fishery environment. In Alaska, there are 29 documented natural oil seeps that put an unknown quantity of crude oil into the water (Becker, 1988). Worldwide, the National Research Council estimates that naturally occurring seepage totals average 185 million gallons of oil a year. According to their 1985 report, the best estimate is that an average of more than one billion gallons of petroleum enter the world's oceans each year, but only about 10% of it comes from tanker accidents. This compares with 37% from municipal and industrial wastes, plus runoff from the land.

The existing body of research from previous spills and observations of the Alaska fisheries provide encouragement that the 1989 oil spill should have had no measurable effect on the size or quality of the harvest in 1989 or 1990, nor should it in the future.

THE EXXON CLAIMS PROGRAM

Within weeks after the *Exxon Valdez* spill, Exxon established claims offices in locations throughout the spill-impacted area so that any adverse economic impact on the fishing industry could be ameliorated. Claims adjusters gave advance payments to fishermen and others suffering hardship due to lack of income.

Through year-end 1990, Exxon reported that it had committed more than $302 million in damage compensation on 12,300 claims. This includes $169 million in payments to more than 7,300 commercial fishermen and individuals employed by fishing permit holders. An additional $133 million was committed to about 5,000 claims to seafood processors, cannery workers, tenderboat owners, and other individuals and businesses affected by the spill.

A major portion of Exxon's payments was based on a set of "Salmon Permit Holders Claims Guidelines" that described the basis under which the company would pay holders of commercial salmon fishing licenses. The key guidelines:

"Individual permit holders will be compensated for their share of the preseason ADF&G projected salmon harvest based on their two-year historical average share of the catch...prices used in final payments will be average market prices for the season."

The adjusters computed a catch value for each fisherman based on the size of the projected harvest and market price. As it turned out, the state's projections were high in Prince William Sound, so Exxon made larger payments than were warranted by the size of the actual run. In Upper Cook Inlet, Kodiak and Chignik, however, claim payments were increased because runs were stronger than projected.

ROLE OF FISHERMEN IN THE CLEANUP

Fishermen who work in Prince William Sound and the Gulf of Alaska proved to be a major resource to Exxon and government officials in their cleanup and wildlife-rescue operations. These fishermen had vessels and equipment that were needed for the operations, and they had expert knowledge of tides and geographical features in the affected areas. The vessel owners and their crews towed booms to contain oil, transported technicians and workers to remote beaches, served as pilots on research boats, helped clean beaches, and rescued sea otters and seabirds.

Exxon paid significant amounts for these services. For example, Exxon hired 1,440 individuals and firms in 1989, including about 1,160 commercial fishermen-claimants, and paid them cleanup wages and vessel-chartering fees in excess of $105 million in addition to the damage compensation they received.

Figures provided by Exxon Company, U.S.A.

6

QUESTIONS AND ANSWERS

The following are answers to questions the authors have been asked about the Alaskan fishery in the wake of the oil spill.

What might explain 1990's extraordinary Prince William Sound pink salmon and herring catches?

There was an unusually abundant plankton bloom in 1989, the largest on record, and this provided an extraordinary amount of food for the pink salmon that were harvested in 1990. The pink salmon harvest reflects the long-term trend of larger catches brought about by increased hatchery releases and a history of good management under the direction of the Alaska Department of Fish and Game. The herring harvest of 1990 included fish that would have been caught in 1989 when the Prince William Sound herring fishery was closed.

Your report concentrates on pink salmon and herring. What about other species of fish?

These two species were chosen because they are important commercially and because they have implications for other species. The record catches of pink salmon and herring are significant because their primary spawning areas are located in shallow intertidal areas that were in close proximity to the spilled oil, and because herring and pink salmon fry swam in the waters of the Sound soon after the spill.

Will the pink salmon and herring harvest levels in 1991 be related to the spill?

In view of the outstanding harvests of pink salmon and herring in 1990, there is no basis to expect any spill-related impacts in future harvests. Fish-harvest predictions are about as reliable as long-range weather forecasts; nature is very unpredictable.

Weren't there reports of significant fish kills immediately after the spill?

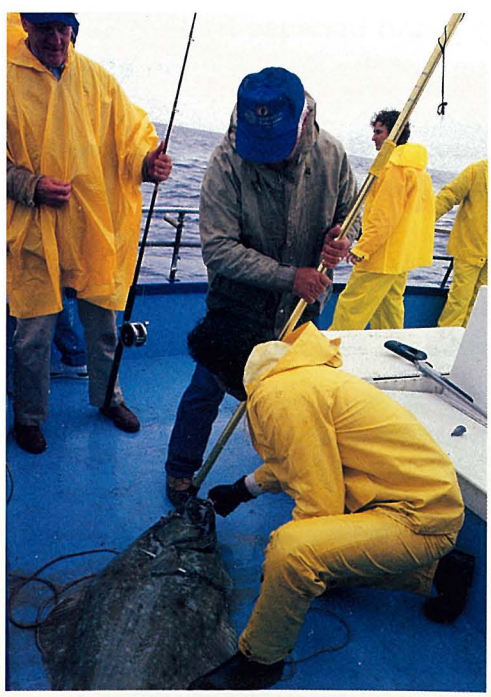
There were no verifiable ones. However, the state reported receiving a few dead rockfish at the time of the spill. These deaths are not known to be associated with the spill.

Why were there low pink salmon returns in the Lower Cook Inlet and Kodiak areas in 1990?

One explanation was a low return from the Tutka hatchery in Lower Cook Inlet and Kitoi Bay hatchery in Kodiak. These were not unusual since there has been an erratic pattern of returns from these hatcheries over the years. The poor 1990 returns were probably not associated with the 1989 oil spill since all hatcheries were protected from oil. Also, part of the Kodiak area was closed for sockeye management reasons, allowing a large number of pink salmon to elude the fishermen's nets.

Won't the 1989 "overescapement" — a surplus of spawners — hurt the salmon populations?

The potential impact of large escapements must literally be analyzed stream by stream, almost inch by inch. In some instances, too many fish entering spawning grounds may reduce the output of a stream. On the other hand, a heavy escapement would be beneficial to streams that are producing below historic levels.



Do hydrocarbons accumulate in fish?

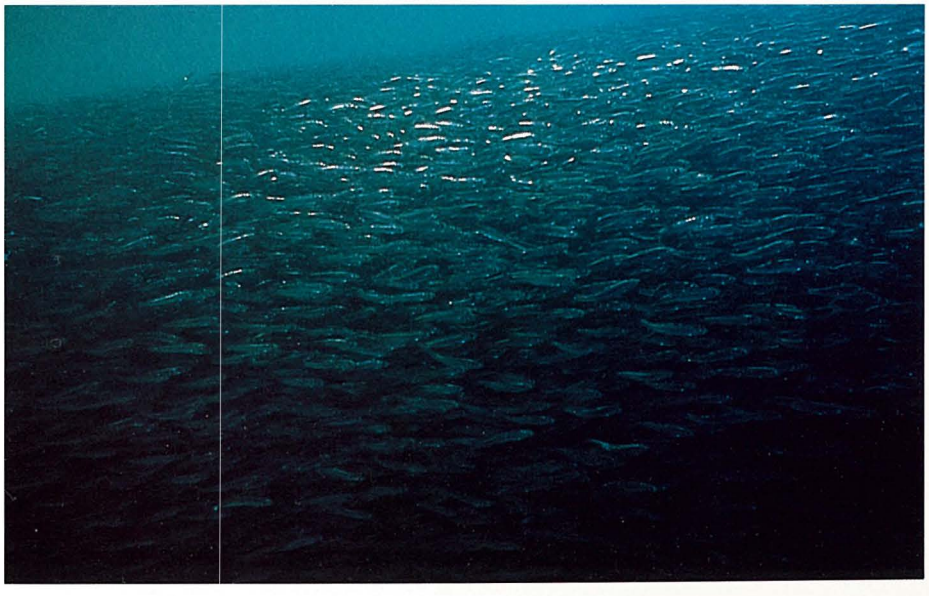
No. Hydrocarbons are not like DDT or other toxins that accumulate through the food chain. Fish have the capacity to metabolize, or naturally break down, hydrocarbons and expel them from their systems.

Are some Alaska fish normally exposed to hydrocarbons?

Yes. There are 29 known naturally occurring oil seeps along the Alaska coast, and there has never been any indication that this constant source of petroleum has harmed a fishery.

What are some of the major threats to our nation's marine fish stocks?

The biggest problems by far are poor fishery management policies, which result in overfishing, and the incidental catch of protected species by those fishing for other species. With proper management strategies, the severity of these problems could be reduced significantly.



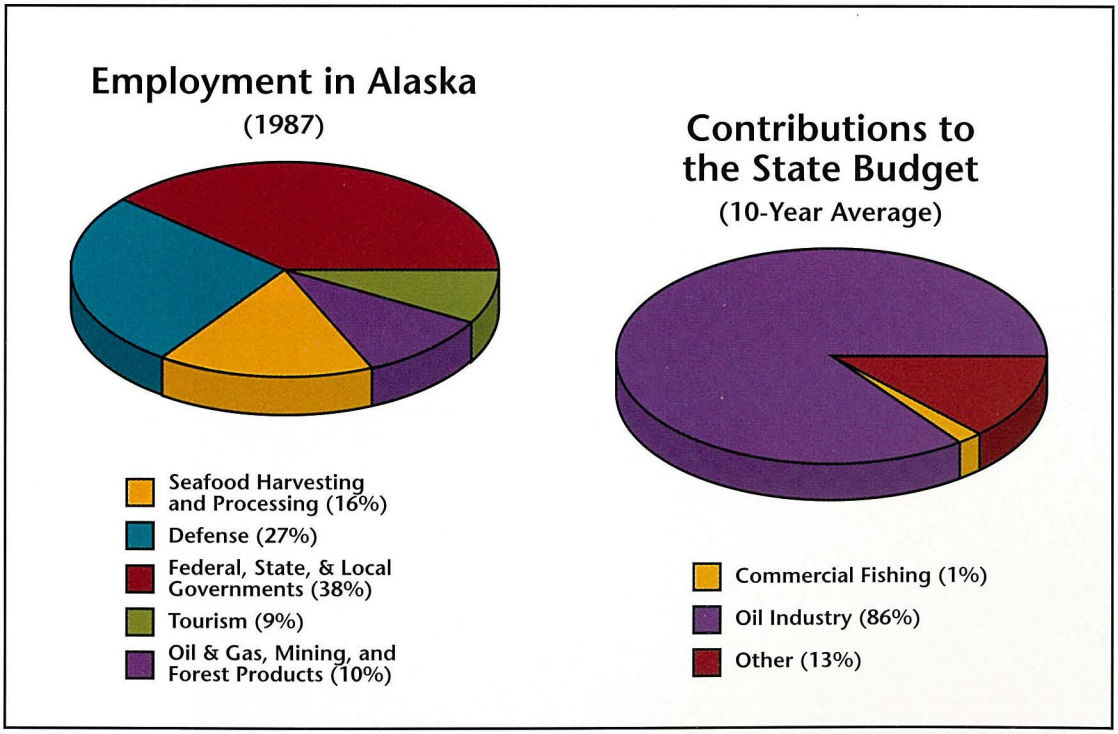
APPENDIX

Commercial Fisheries in Alaska

Alaska is by far the most important fishing state in the United States, accounting in 1989 for almost half the nation's catch in pounds and 38% in value. No other state comes close to Alaska in either category, according to statistics compiled by the U.S. Department of Commerce. The Alaska harvest includes salmon, herring, shellfish, pollock and halibut, with salmon and shellfish producing a majority of the value.

Alaska is a major exporter of fishery products. Seafood valued at $561 million was shipped overseas in 1987, with all but 5% going to Japan. That represented one-third of the U.S. seafood exports.

The seafood industry is the largest non-governmental employer in Alaska, providing 16.4% of the state's jobs. A 1989 study prepared for the Alaska Seafood Industry Study Commission concluded that the seafood industry provides "nearly 70,000 seasonal jobs, which translates to 33,000 direct, indirect and induced year-round jobs." The report, written by the McDowell Group of Juneau, estimated total seafood industry payroll for 1987 at $596 million.



Although the fishing industry is Alaska's largest private employer, the oil industry provides an average of 86% of state and local government tax revenue.

Although the seafood industry is the second largest source of state and local government tax revenue, it trails the oil and gas industry by a wide margin. According to media reports and a fiscal policy paper issued by the Institute of Social and Economic Research at the University of Alaska at Anchorage, oil production provides more than $2.5 billion a year in support for state and local government, compared to about $50 million in taxes on marine motor fuels and the harvesting of fish. The oil industry provides an average of 86% of total state government revenue.

Alaska's income from the oil industry is so great that the state pays each citizen an annual dividend known as a permanent-fund payment, which in 1990 amounted to $952 per person. Anyone 65 or over who has lived in Alaska for one year is also entitled to a "longevity bonus" of $250 a month. The Alaska revenue structure is highly unusual, with no personal income tax or state sales tax levied. In addition, local property taxes are approximately 20% below the national average.

Alaska's Management of Commercial Fisheries

Three decades ago, Alaska's commercial fisheries were described as the victim of a "pathetic history of ruinous exploitation." Until 1961, Alaska's fishery management was in the hands of the federal government, which allowed the industry to catch salmon and other fish "almost unrestrained," according to Dr. William F. Royce, one of the authors of this report, writing in the March/April 1989 issue of *Fisheries* magazine.

After the Alaska Department of Fish and Game took over management of the resource, conservationist steps were taken to limit commercial fishing licenses and to prevent depletion of the species. Today, Alaska has the best managed commercial fisheries in the nation because the state has "separated much of the politics of conservation from the politics of economics and equity," Royce wrote. The per-fish cost to Alaska for salmon management is only about 3% as much as the cost per fish in other Pacific coast states.

Aside from the restricted number of fishing licenses, the key to Alaska's management program is the unique emergency-order authority held by the chief management biologist in each fishery area to preserve the resource as well as the quality of Alaska's seafood products. Based on their unique knowledge of water conditions and fish population levels, biologists have the extraordinary power to open and close fishing areas minute by minute and stream by stream.

The state, which encompasses an area as large as one-third of the lower 48 states, is divided into 15 management areas, each with numerous districts and sub-districts. Fishing regulations vary from area to area, depending upon the conditions each biologist encounters. Close communication and cooperation between the state officials and working fishermen are a key to success of the program.

In the three decades of decentralized control, the state has essentially doubled the salmon run. Despite these controls, however, the size of each salmon run remains unpredictable since biologists never know how fish are going to survive in the ocean and return to their spawning grounds as adults.

Forecasting the annual catch of herring for the sac-roe puts fishery biologists to the supreme test. Where else do you find a fishery with perhaps a 20-minute open season? In Prince William Sound, the sac-roe season can range from less than half an hour to more than several hours, and a successful fisherman may have 300 tons of herring in his net — or may miss the season entirely. The sac-roe season must be short because herring gather in huge schools and a lengthy opening would result in severe over-harvest of the resource.

Following the spill, local biologists retained their autonomy over the opening and closing of the fisheries, but they were placed under a "Zero-Tolerance Policy" designed to guarantee that the quality of Alaskan seafood would not be questioned. The policy was stated in a memorandum of understanding between the two state agencies responsible for protecting the fishery, the Department of Fish and Game and the Department of Environmental Conservation. The key section:

> *A fishing area will remain closed if there is an indication of oil in any quantity in the area or proximity of the area (including beaches), such that there is an appreciable likelihood that gear will be fouled, fish harvest adulterated, or such that the conduct of an orderly fishery could not take place.*

This stringent policy, which resulted in the closing of most of Prince William Sound, Lower Cook Inlet and Kodiak and portions of two other fishing areas in 1989, was designed to prevent adverse impacts on the perception of high quality that consumers associate with Alaskan seafoods. Although scientists indicated that finfish throughout the area would be safe to eat so long as fishing gear remained free of oil, the state elected a conservative policy that kept all commercial fishing vessels out of oiled areas.

In addition to closing fishing areas, the Alaska Department of Environmental Conservation and the U.S. Food and Drug Administration beefed up inspection activities on fishing vessels to guarantee that no fish were contaminated by crude oil. Inspectors were also deployed on fish-transport or tender vessels and in processing plants. Throughout the 1989 and 1990 seasons, there were no reports of fish contamination from *Exxon Valdez* oil on fishing boats, on tenders or in processing plants.

REFERENCES

The following bibliography includes literature specifically cited in this report, as well as other material concerning fisheries and oil spills.

Alaska Department of Fish and Game. "Announcement 24: Prince William Sound Commercial Fishing Announcement, Salmon Season." 1990.

Alaska Department of Fish and Game. *Preliminary 1990 Season Summary of the Alaska Commercial Salmon Catch.* 1990.

Alaska Department of Fish and Game and Alaska Department of Environmental Conservation. "Memorandum of Understanding Regarding 1990 Commercial Fishery Season." 1989.

Alaska Department of Health and Social Services, Section on Epidemiology. "Oil Spill Public Health Advice – Report Number 2." July 1989.

Alaska Department of Health and Social Services, Section on Epidemiology, "Oil Spill Public Health Advice – Report Number 3." September 1989.

Anderson, Ross. "A Surprise Catch in Prince William Sound: Spill-Hit Waters Produce Huge Salmon Catch." *Seattle Times.* August 1990.

Baker, J.M., *et al. Natural Recovery of Cold Water Marine Environments After an Oil Spill.* Thirteenth Annual Arctic and Marine Oil Spill Program, 1990.

Becker, Paul R. and Carol-Ann Manen. *Natural Oil Seeps in the Alaskan Marine Environment.* National Oceanic and Atmospheric Administration, 1988.

Bernton, Hal. "Should Fishermen Pay More Taxes?" *Anchorage Daily News.* June 3, 1990.

Brady, James A. *1990 Prince William Sound Herring Season Summary.* Alaska Department of Fish and Game, 1990.

Brady, James A. *1990 Prince William Sound Salmon Season Summary.* Alaska Department of Fish and Game, 1990.

Brady, James A., *et al. Review of the Prince William Sound Area Commercial Herring Fisheries.* Alaska Department of Fish and Game, 1990.

Bucher, Wesley. *1990 Salmon Fishery Summary – Lower Cook Inlet.* Alaska Department of Fish and Game, 1990.

Clark, R.B., editor. *The Long-Term Effects of Oil Pollution on Marine Populations, Communities and Ecosystems.* The Royal Society, 1982.

Engstrom, Ron. Chart. "Salmon Harvest Ranks With Best." *Anchorage Daily News*. August 25, 1990.

Engstrom, Ron. Charts. "Should Fishermen Pay More Taxes?" *Anchorage Daily News*. June 3, 1990.

Exxon Shipping Company. "Salmon Permit Holder's Claims Guidelines." 1989.

Fall, James H. *Subsistence After the Spill: Uses of Fish and Wildlife in Alaska Native Villages and the* Exxon Valdez *Oil Spill*. Alaska Department of Fish and Game, 1990.

Galt, Jerry A., *et al.* "Fate and Transport of the *Exxon Valdez* Oil Spill." *Environmental Science and Technology*. February 1991.

Hamilton, J.M., *et al. Petroleum Hydrocarbons in the Earth's Ecosystem*. Exxon Production Research Company, 1989.

Hart, J.L. *Pacific Fishes of Canada*. Fisheries Research Board of Canada, 1973.

Institute of Social and Economic Research. "Alaska's Potential Tax Revenues." *ISER Fiscal Policy Papers*. University of Alaska Anchorage, February 1990.

Loshbaugh, Doug. "1990 Salmon Season Is Best in History." *National Fisherman*. December 1990.

McDowell Group. *Alaska Seafood Industry Study*. Alaska Seafood Industry Study Commission, 1989.

Maki, Alan W. "The *Exxon Valdez* Oil Spill: Initial Environmental Impact Assessment." *Environmental Science and Technology*. January 1991.

Mallory, Larry. *1989 Kodiak Area Salmon Management Report to the Alaska Board of Fisheries*. Alaska Department of Fish and Game, 1989.

Mielke, James E. *Oil in the Ocean: The Short- and Long-Term Impacts of a Spill*. Congressional Research Service, The Library of Congress, 1990.

National Research Council, National Academy of Sciences. *Oil in the Sea: Inputs, Fates and Effects*. 1985.

Neff, Jerry M. *Water Quality in Prince William Sound*. Battelle, 1990.

Neff, Jerry M., et al. *Petroleum Hydrocarbons in the Water Column of Prince William Sound, Alaska*. American Society of Civil Engineers, 1990.

Oil Spill Health Task Force. February 1990 Report.

Oil Spill Health Task Force. March 1990 Report.

Oil Spill Health Task Force. July-August 1990 Report.

Prince William Sound Aquaculture Corporation. "PWSAC News, September 1989."

Prince William Sound Aquaculture Corporation. "PWSAC News, March 1990."

Quantitative Risk Assessment Committee. *Estimation of Risk Associated with Consumption of Oil-Contaminated Fish and Shellfish by Alaskan Subsistence Fishermen Using a Benzo(a)Pyrene Equivalency Approach.* U.S. Department of Health and Human Services, Public Health Service, 1990.

Roser, Louis A. "Where the Salmon Go." *Field and Stream.* April 1989.

Royce, William F. "Managing Alaska's Salmon Fisheries for a Prosperous Future." *Fisheries Magazine.* March/April 1989.

Ruesch, Paul. *1989 Upper Cook Inlet Salmon Season Summary.* Alaska Department of Fish and Game, 1989.

Savikko, Herman and Tim Page. *1989 Preliminary Alaska Commercial Fisheries Harvests and Values.* Alaska Department of Fish and Game, 1990.

Schroeder, Thomas R., *1989 Lower Cook Inlet Salmon Season Summary.* Alaska Department of Fish and Game, 1989.

Spaulding, Malcom L. and Mark Reed, editors. *Oil Spills: Management and Legislative Implications.* American Society of Civil Engineers, 1990.

Thompson, Frederick M. and Jeff R. Fox. *Chignik Management Area Salmon Fishery Report to the Board of Fisheries.* Alaska Department of Fish and Game, 1989.

U.S. National Marine Fisheries Service. "U.S. Commercial Landings." 1990.

Villeneuve, Renee. "Record Catch in 'Fouled' Prince William Sound." Garnett News Service. September 2, 1990.

Whitmore, Craig, Doug Vincent-Lang and Kelly Hepler. *Sport Fish Division Annual Management Report for the Prince William Sound Management Area.* Alaska Department of Fish and Game, 1991.

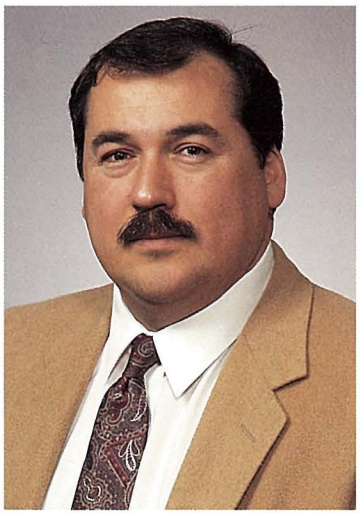
BIOGRAPHICAL SKETCHES OF THE AUTHORS

William F. Royce, Ph.D.

A consulting fisheries scientist, Dr. Royce is a Professor Emeritus of Fisheries in the College of Ocean and Fishery Sciences of the University of Washington in Seattle and a retired executive of the United States National Marine Fisheries Service. After receiving his doctorate in zoology from Cornell University in 1943, he held a number of research and administrative positions for the Fish and Wildlife Service, including directorship of the Woods Hole (Massachusetts) Laboratory and assistant regional director in charge of research in Juneau, Alaska. In 1958, he became a fisheries professor and director of the Fisheries Research Institute at the University of Washington. During periods of leave, he was employed as a consultant on a variety of fisheries problems around the world. In 1972, he was appointed Associate Director in Charge of Resource Research for the National Marine Fisheries Service in Washington, D.C. Dr. Royce is the author of more than 100 scientific publications, including books entitled *Introduction to the Fishery Sciences*, *Introduction to the Practice of Fishery Science*, and *Fishery Development*. A fellow of the American Association for the Advancement of Science and of the American Institute of Fishery Research Biologists, he has been a member of the American Fisheries Society since 1935 and was elected to honorary membership in 1983.

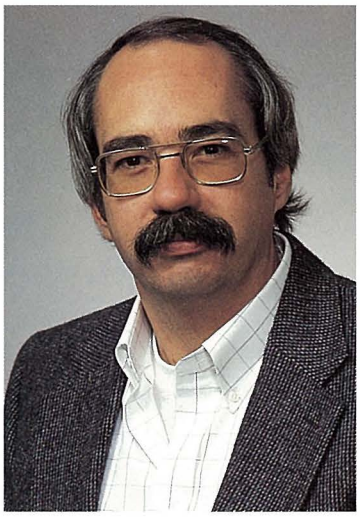
Thomas R. Schroeder

Schroeder has worked almost his entire adult life managing fisheries in Alaska. He received his bachelor's degree in fisheries science from Colorado State University in 1967, and wrote a thesis on toxicity of pesticides and herbicides to salmon and trout while working on a master's degree. He joined the Alaska Department of Fish and Game's Division of Commercial Fisheries in 1969 as an assistant area biologist in Bristol Bay. In 1974, he was promoted to area management biologist for Lower Cook Inlet, one of the areas affected by the *Exxon Valdez* spill, and managed salmon, herring, bottomfish and shellfish fisheries until retiring in April 1990. Following the spill, he walked the beaches of Prince William Sound and the Gulf of Alaska with other state officials to examine the extent of oiling. A member of the American Fisheries Society since 1965, he is now a private fisheries consultant based in Homer, Alaska.



A.A. "Ole" Olsen

Olsen, a fisheries consultant in Anchorage, is a native Alaskan born in the small coastal village of Afognak, which was destroyed by a tidal wave in 1964. He worked on his family's fishing boats before launching an eight-year career as a bush pilot and salmon spotter flying throughout the state. In 1977, he entered the seafood processing industry as the manager of a salmon cannery and spent 10 years as an executive for firms packing fresh, frozen and canned salmon, crab and other fish for sale throughout the world. Following the spill, he was retained by Exxon as a consultant on commercial fisheries programs and as a liaison to villages of Alaskans whose diet consists largely of the fish and game they catch. He studied engineering and business for two years at the University of Portland, Oregon, and business for three years at the University of Alaska at Fairbanks.



William J. Allender

Over the past 15 years, Allender has worked in Alaskan canneries, on a hatchery construction crew and in several commercial fishing operations. For almost 10 years, he earned his living diving for herring roe in kelp beds and fishing for salmon, herring and bottomfish, with much of his experience in the area affected by the oil spill. Since 1988, he has operated Marcor Charters, a sport fishing business out of Cordova. A native of Big Fork, Minnesota, he is a Coast Guard-licensed captain for carrying passengers and cargo. Following the 1989 oil spill, he worked for 160 days on animal-rescue and eagle-capture teams. In 1990, as a consultant to Exxon, he traversed the beaches and waters of Prince William Sound and the Gulf of Alaska to help state officials ensure the safe operation of fisheries in the region.

This paper was funded by Exxon Company, U.S.A.

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