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Water Quality in Prince William Sound

April, 1990

A summary of findings from the report by

Jerry M. Neff, Ph.D.
Senior Research Leader
Battelle Ocean Sciences
Duxbury, Massachusetts

 **Battelle**
... Putting Technology To Work

WATER QUALITY IN PRINCE WILLIAM SOUND

Within six days of the oil spill in Prince William Sound, Alaska, independent contract research organizations (Arthur D. Little Marine Sciences, Battelle Ocean Sciences, Kinetic Laboratories, Inc. and the Alaskan firm, America North, Inc.) were engaged by Exxon to monitor the distribution, concentrations, and changes over time of petroleum hydrocarbons in the water column (the area between the ocean surface and above the sea floor) throughout Prince William Sound.

The studies ran from March through October of 1989. During that period, more than 2,300 offshore and nearshore water samples were taken from 61 locations throughout the Sound (Figure 1). Sampling sites included three of the most heavily oiled areas at Smith Island, the Bay of Isles, and Herring Bay. Both state and federal agencies were involved in the selection of sample stations, and state representatives were present on most of the field surveys.

Battelle Ocean Sciences used the findings of the four firms, along with extensive scientific research on the effects of previous oil spills, to compile a report entitled Water Quality in Prince William Sound. The report was written by Dr. Jerry M. Neff, Senior Research Leader of Battelle Ocean Sciences. This brochure presents and explains the primary conclusions from Dr. Neff's report.

WHAT ARE THE SCIENTIFIC FACTS?

- It is extremely unlikely that hydrocarbon concentrations resulting from the spilled oil have had or will in the future have any adverse effects on plants and animals living below the surface in the water column of Prince William Sound, including commercial fishery species.
- Despite initial damage to plants and animals occupying the ocean surface or living on heavily oiled shores, there have been no verified reports of mortalities or adverse effects on animals living in the water column.
- Concentrations of petroleum hydrocarbons below the water surface in the water column have remained consistently low since early April, 1989 (Figures 2 and 3). In most cases, they are 10 to 1000 times below the concentrations found to cause harm to marine animals.
- Throughout most of the open waters of Prince William Sound, the concentrations of potentially toxic components of oil -- volatile aromatic hydrocarbons (VOA), such as benzene, toluene, and xylene, and polycyclic aromatic hydrocarbons (PAH), such as naphthalene and phenanthrene -- returned to essentially background levels by May, 1989, and have remained there ever since (Figures 2 and 3).
- Remaining microscopically-thin surface sheens of weathered crude oil in several heavily oiled bays contain only traces of potentially toxic PAH, and do not pose a hazard to water column organisms or to wildlife occupying the sea surface.



Figure 1: Offshore Sampling Stations in Prince William Sound

SOME IMPORTANT QUESTIONS AND ANSWERS

Q. *What assurances can citizens have that the study was thorough and accurate?*

A. The Prince William Sound water quality study is the most comprehensive water study of its kind in history. To ensure that water quality was tested accurately, frequent sampling was begun soon after the spill. Over 2,300 samples were collected through October, 1989. Well-documented and audited procedures were used during both sampling and analysis. Independent laboratories were used for all sampling and analysis. In addition, representatives of the State of Alaska were present as observers during field surveys.

Q. *What did the scientists find?*

A. Scientists found that for a brief period in April-May, 1989, in regions of the Sound where the oil spread, there was an increase in the upper water column in the average concentration of aromatic hydrocarbons -- the potentially toxic components of crude oil. However, these slightly elevated average concentrations were always well below the State of Alaska standard for aromatic hydrocarbons in marine waters. In May, they returned to background levels.

Q. *Will the levels of aromatic hydrocarbons found in the water column of Prince William Sound make fish sick, and will they cut down on fish production?*

A. Average water column concentrations of aromatic hydrocarbons, the toxic fraction of oil, are now and have consistently remained below levels that are known to be harmful to plants and animals, such as phytoplankton, zooplankton, and fish larvae. Adult species of fish are even more resistant to harmful effects, since they have the ability to rapidly break down aromatic hydrocarbons and excrete them.

Q. *How can studies predict the long-term effect of a major oil spill on water column plant and animal life, including commercial fish species?*

A. In making predictions, scientists are able to draw upon the findings of other research into the short and long-range effects of other oil spills, such as the Amoco Cadiz, which was six times larger than the one at Valdez. The Cadiz study, for example, showed that potentially toxic hydrocarbon concentrations did not persist in the edible tissues of fish. Based on this and other studies, there is no reason to anticipate any harmful effects in 1990 and beyond of the remaining spilled oil on water column organisms, including commercially-important herring and salmon populations.

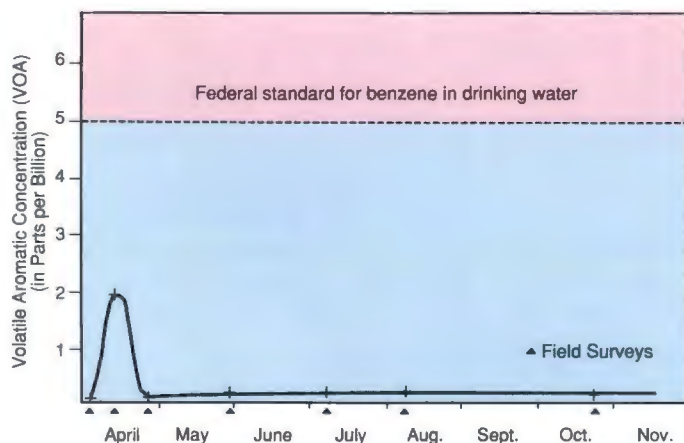


Figure 2
Average Volatile Aromatic Concentrations
for Primary Sites

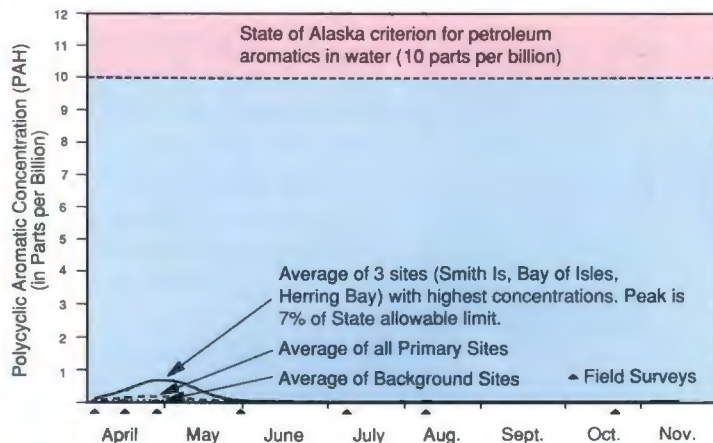


Figure 3
Average Polycyclic Aromatic Concentrations

About Battelle

Battelle Memorial Institute is one of the world's largest independent research organizations with a staff of over 7,500 research and support personnel in four major research centers and other specialized facilities around the world. At its Ocean Sciences' marine research facility in Duxbury, Massachusetts, Battelle provides contract research and management services to government and private industry in the areas of marine chemistry, toxicology, and biological and physical oceanography. Battelle brings state-of-the-art science to bear on the development and analysis of information required for the effective management of ocean resources.

About Arthur D. Little

Arthur D. Little, Inc. (ADL) is a multinational technology and management professional services company with headquarters in Cambridge, Massachusetts. Its 2,500 staff members undertake consulting assignments in some 60 countries through its international network of offices and laboratories. ADL's internationally recognized Marine Sciences Unit conducts complex field and laboratory assignments that include oil spill natural resource damage assessments, offshore oil production and exploration issues, harbor and coastal management, and pollution monitoring.

About America North, Inc.

America North, Inc. is an Alaska-based environmental consulting/management company. Areas of specialization include site investigation, environmental sciences, health and safety, and database management. Employing a staff of 50 professionals, America North offers clients a full range of services backed by a wide range of experience. America North is familiar with Alaska, having worked throughout the state from Prudhoe Bay on the North Slope to the temperate Southeast.

About Kinnetic Laboratories, Inc.

Kinnetic Laboratories, Inc. is a specialized firm offering oceanographic and environmental science services in the biological, chemical, and physical disciplines. Their expertise in the biological sciences is particularly comprehensive and widely recognized. Kinnetic has extensive experience in studying trace pollutant problems in marine systems. Kinnetic also has a long history in Alaska, and has the logistical and field capabilities to obtain high quality data.

About the author



Dr. Jerry M. Neff, Senior Research Leader with Battelle Ocean Sciences, is an internationally recognized authority on the fate and effects of pollutants in marine and freshwater environments. During the past 20 years he has participated in or managed more than 100 basic or applied research projects dealing with the effects of pollutants on estuarine and coastal marine ecosystems. Dr. Neff is author or co-author of over 120 articles and reports and has written two books dealing with petroleum and aromatic hydrocarbon pollution of aquatic environments as well as a major literature review on recovery of pollution-damaged marine ecosystems. He has been a member of three review panels of the U.S. National Academy of Sciences, one of which dealt with petroleum in the marine environment.

Copies of the full report may be obtained by writing:
Dr. Jerry M. Neff, Battelle Ocean Sciences
Duxbury Operations
397 Washington Street, P.O. Drawer AH
Duxbury, Massachusetts 02332-0601

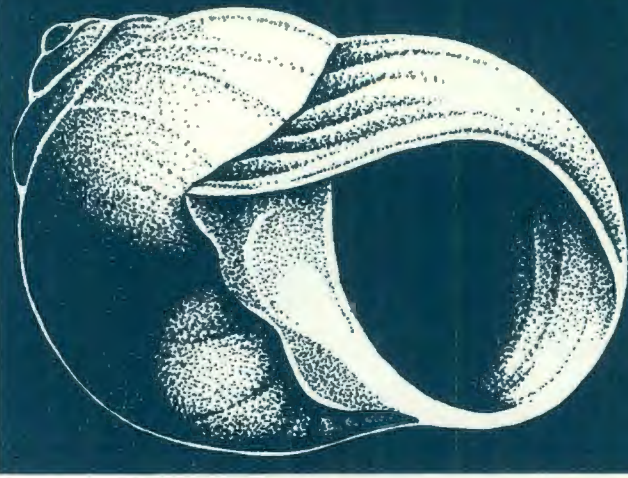
Cordova's Prince William Sound Science Center, centrally located on the southeastern shores of Prince William Sound, is a research facility established to conduct and assist basic and applied research in the Prince William Sound region of Alaska. Incorporated in April, 1989, as the Prince William Sound Science and Technology Institute, the Science Center is a private, nonprofit institution that provides an environment where scientists can work, discuss and exchange ideas in a creative and cooperative atmosphere.

For the past 15 years, Cordova-based researchers have promoted the concept of a centralized research institute in the Prince William Sound and Copper River Delta region to facilitate a deeper understanding of the biological processes at work in this unique diversity of subarctic habitats. Such a facility would serve as a base of operations, help identify research needs and act as an information repository for research conducted in Prince William Sound and the Copper River Delta.

The March 24, 1989, Exxon Valdez oil spill in Prince William Sound accelerated the need for basic and applied ecological research on the effects of oil spills in subarctic regions. Recognizing this need, a group of local scientists, representatives of the fishing industry, and city officials incorporated the Center in April 1989 as a research facility where scientists may conduct both non-oil and oil-related scientific studies. A Board of Directors provides overall policy and a Scientific Advisory Board formulates the scientific direction of the Center.

The purpose of the Center is the following:

- Provide laboratory space, equipment, and logistical and administrative support for research scientists and students.
- Assist development of a long-term environmental monitoring program for the accumulation of baseline data on Prince William Sound and its environs.
- Support other institutions and agencies conducting research in Prince William Sound and the Copper River Delta region.
- Facilitate and fund research projects in Prince William Sound and its associated drainage basins.
- Serve as a repository for scientific information resulting from research



PRINCE WILLIAM SOUND SCIENCE CENTER

C O R D O V A , A L A S K A

in Prince William Sound and the Copper River Delta region.

- Act as a host institution to the Prince William Sound Oil Spill Recovery Institute.
- Develop scientific information and education programs for students and the general public.
- Serve as an interpretive center for the general public.

The present Center, located on the dock on Breakwater Avenue, has two administrative offices, bunkhouse space for five to seven researchers, a kitchen, and a lunch room-meeting area. One-third of the 3,900-square-foot building is being converted into laboratories and a teaching facility.

Long-term, the Center plans to provide:

- Fully equipped laboratory and office facility
- Living and dining quarters for 30
- Central warehouse and smaller warehouse units for member institutions or projects
- Library
- Dock facilities
- Research vessels and field research equipment
- Classroom and other educational facilities, including an interpretive center and auditorium.

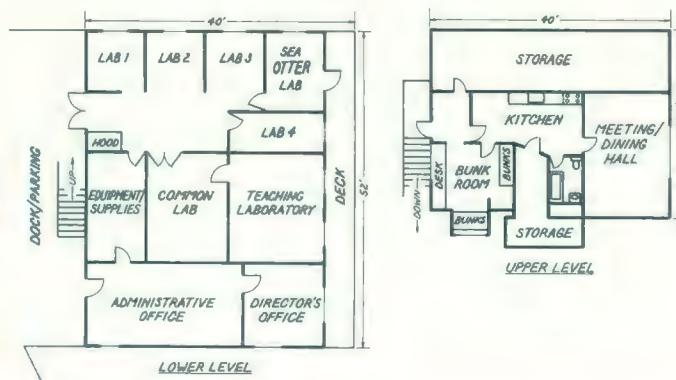
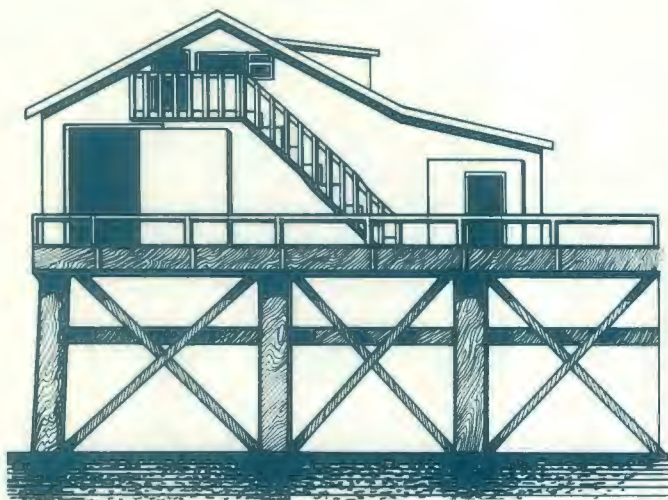
Although the Center's current emphasis is oil spill related, the original concept of creating a center to serve Prince William Sound and Copper River Delta research in perpetuity remains the pri-

mary goal, and will re-emerge as the Center's most important function as the need for oil spill-response research lessens in decades to come.

Cordova, a community of 2,650, is economically dependent on fishing which is in turn dependent upon a healthy ecosystem. The city strongly supports the Center, not only because scientific inquiry and technological development promise to help perpetuate high quality fisheries in Prince William Sound, but also because the Center itself represents diversity, and provides further economic stability to a community primarily dependent upon commercial fishing.

The Center has also received broad support from both private and public agencies, many of which are conducting post-spill research activities in Prince William Sound out of Cordova. These agencies have found Cordova to be the most logical base of operations because of its proximity to oil-impacted areas of the Sound, its proximity to the rich flats of the Copper River Delta, its role as a hub of commercial fishing activity (it is the nation's ninth largest fishing port by value), and its facilities, which include a modern airport and hospital.

The Prince William Sound area has long attracted researchers in both the basic and applied sciences because of its habitat diversity and natural resource wealth. At 15,000 square miles, Prince William Sound, a relatively deep, glacially-



Prince William Sound Science Center

carved fjord, is about 15 times the size of San Francisco Bay. In addition to being one of the world's richest herring and salmon fisheries, its waters and 3,000 miles of shoreline support tremendous numbers of sea birds and marine mammals.

In addition, PWS is adjacent to the Copper River Delta which is the largest contiguous wetland in the western United States. The two million acres of marshland, rivers, streams and ponds of the Delta are home to millions of waterfowl, shorebirds, salmon, trumpeter swans, moose, bear, wolves and many other species of wildlife. The Delta is the only known breeding area for dusky Canada geese and supports more than 11 percent of the world population of trumpeter swans. The USDA-Forest Service recognizes the need for researchers to study this rich wetland habitat and has established the Copper River Delta Institute in Cordova for that purpose. The Science Center will work closely with the Delta Institute to coordinate research and education efforts.

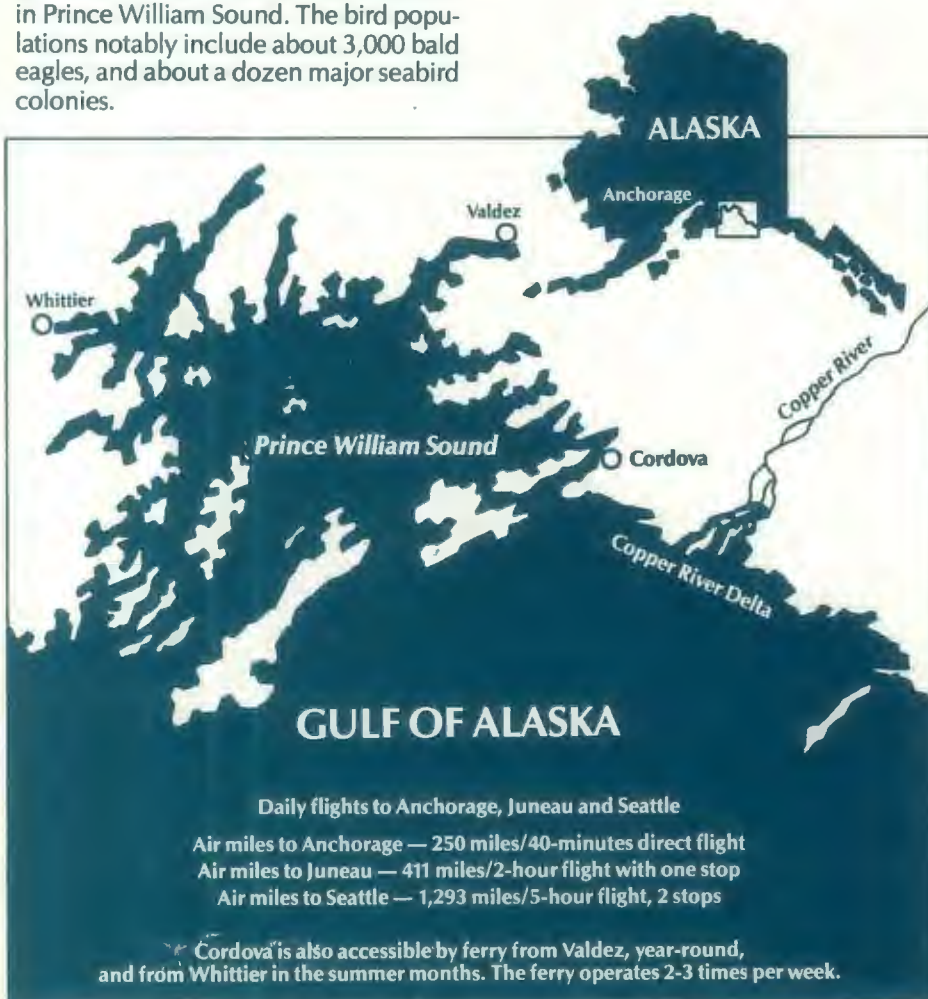
The waters of Prince William Sound support one of the nation's richest combination of salmon and herring fisheries, with an ex-vessel value of about \$85 million in 1988. Other important fisheries include dungeness crab, shrimp, halibut and other groundfish. Five major salmon hatcheries operate in the Sound. Three of

those are managed by Prince William Sound Aquaculture Corporation, including the world's largest hatchery at Esther Island.

The Sound is home water to some of the world's densest populations of sea otters and killer whales, which together with other cetaceans, seals and sea lions represent one of the more profuse populations of marine mammals anywhere.

Two hundred and forty species of birds — including waterfowl, raptors, seabirds, shorebirds and songbirds that aggregately number in the tens of millions, are found in Prince William Sound. The bird populations notably include about 3,000 bald eagles, and about a dozen major seabird colonies.

The Science Center's primary goal is to facilitate research that increases the understanding and knowledge of the biological, chemical and physical processes at work in the unique subarctic environment of southcentral Alaska. A better understanding of these processes will benefit resource managers and the general public by providing essential information for the continued health and diversity of Prince William Sound and the Copper River Delta.



Prince William Sound
Science Center
Box 705
Cordova, Alaska 99574
(907) 424-5800
FAX (907) 424-5820

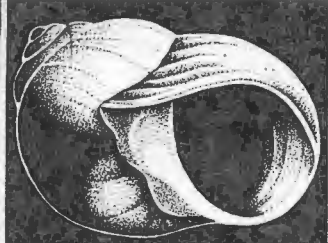
Daily flights to Anchorage, Juneau and Seattle

Air miles to Anchorage — 250 miles/40-minutes direct flight

Air miles to Juneau — 411 miles/2-hour flight with one stop

Air miles to Seattle — 1,293 miles/5-hour flight, 2 stops

Cordova is also accessible by ferry from Valdez, year-round, and from Whittier in the summer months. The ferry operates 2-3 times per week.



PRINCE WILLIAM SOUND
SCIENCE CENTER
CORDOVA, ALASKA

We invite you to join in our efforts
and become a member of the
Prince William Sound Science Center

HELP the PWSSC launch long-term research in Prince William Sound. Contribute to a better understanding of your environment and build a strong base of scientific information that can be used by those who manage the Sound. Support Alaska by supporting science and giving the environment a future. Become a member of the Prince William Sound Science Center.

AS A SCIENCE CENTER MEMBER, you will receive an enamel logo pin and our semi-annual newsletter along with other information about the Center's development and work.

SCIENCE CLUB for children, grades 4-6 meet Mondays, 3:30-4:30 p.m.; grades K-3 meet Thursdays, 3:30-4:30 p.m. at the community college. All students interested are welcome. Volunteer helpers needed!!!

SCIENCE LECTURE SERIES is offered for adults and those children interested on a monthly basis. Watch for advertisements!

MEMBERSHIP AND DONATION FORM

YES, I would like to join the Prince William Sound Science Center. Enclosed is \$_____ for my membership for the category selected below.

The PWS Science Center is incorporated as a 501c3 non-profit corporation and has applied for its tax-deductible status.

* SPECIAL
Christmas offer
All regular
memberships
\$10

- | | |
|---------------------------|-------------------------|
| _____ \$10 Student/Senior | _____ \$100 Contributor |
| _____ \$15 Regular* | _____ \$1,000 Supporter |
| _____ \$25 Family | _____ \$2,500 Sustainer |
| | _____ \$5,000 Patron |

Membership donations of \$1,000 or more will receive special recognition at our permanent facility.

Name _____

Address _____

City/State/Zip _____

GIFT MEMBERSHIP

I would like to give a membership as a gift to:

Name _____

Address _____

City/State/Zip _____

A letter announcing your gift will be sent directly to the individual listed above.

THANKS FOR YOUR SUPPORT!



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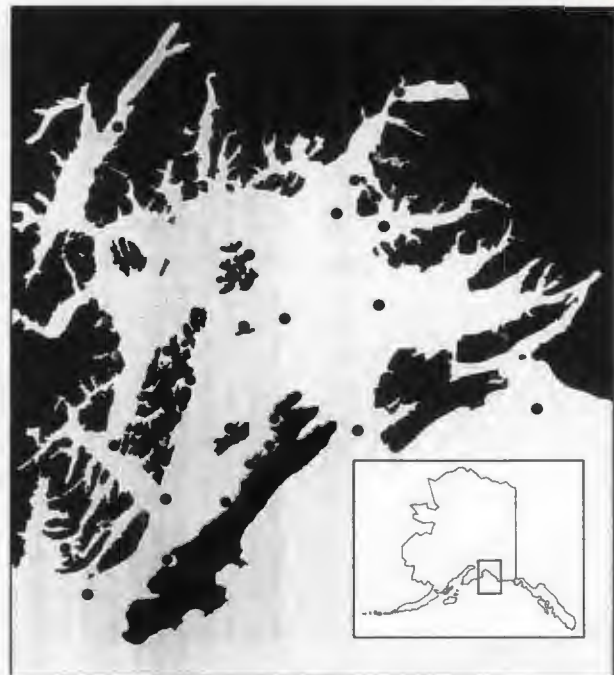


Figure 1: Offshore Sampling Stations in Prince William Sound

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Q. *What assurances can citizens have that the study was thorough and accurate?*

A. The Prince William Sound water quality study is the most comprehensive water study of its kind in history. To ensure that water quality was tested accurately, frequent sampling was begun soon after the spill. Over 2,300 samples were collected through October, 1989. Well-documented and audited procedures were used during both sampling and analysis. Independent laboratories were used for all sampling and analysis. In addition, representatives of the State of Alaska were present as observers during field surveys.

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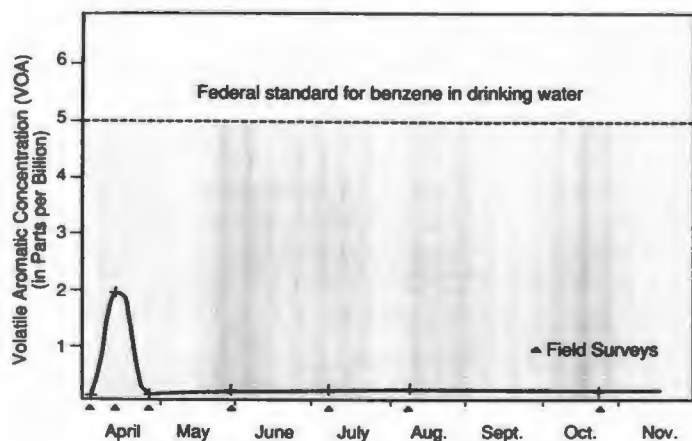


Figure 2
Average Volatile Aromatic Concentrations
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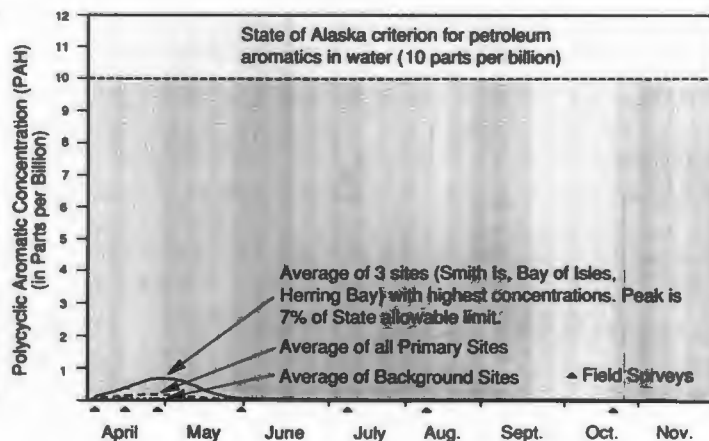


Figure 3
Average Polycyclic Aromatic Concentrations

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About the author

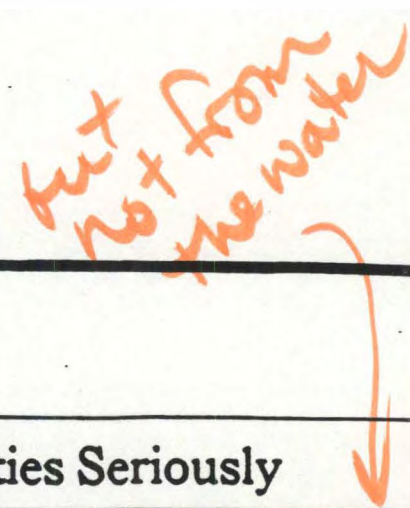


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Dr. Jerry M. Neff, Battelle Ocean Sciences
Duxbury Operations
397 Washington Street, P.O. Drawer AH
Duxbury, Massachusetts 02332-0601

Letters

but + from
not + the water



Exxon Takes Its Environmental Responsibilities Seriously

To the Editor:

The senior management of the Exxon Corporation and, for that matter, all of our employees and dealers, are distressed that this company's reputation has been so diminished by the Exxon Valdez accident and more recent events.

I believe an objective appraisal of the actions we have taken and are taking do not support your characterization (editorial, Feb. 14) that we are "casual" in our concern for the environment or "cavalier" in dismissing the consequences of the accidents in Alaska last March or at the Bayway refinery near New York City.

We stepped forward at the beginning, unequivocally, to accept responsibility. In the cleanup, we have cooperated with and taken direction from the Coast Guard, the responsible authority, and continue to do so. We are devoting people and money to cleaning up and to a reappraisal and follow-up of safety policies worldwide.

In Alaska, we made removal of the remaining oil from our grounded tanker our priority, preventing a much worse spill. We then mounted the largest shoreline cleanup ever undertaken, spending more than \$2 billion so far. We used as many as 1,400

vessels, 80 aircraft and more than 11,000 workers — most had to be transported, housed, fed, outfitted and trained to work safely in a remote, severe environment.

We share your admiration for actions by Johnson & Johnson and Perrier in withdrawing contaminated products from sales outlets. However, removing oil from a shoreline is profoundly more complex. We regret the terrible impact the spill had on wildlife. Nevertheless, no human life was jeopardized, and we did the nearest equivalent of product withdrawal

— we acted as quickly and extensively as we could to remove the offending oil from the shoreline.

We promptly and voluntarily paid restitution advances to Alaskan fishermen and businesses whose livelihood was jeopardized by the spill without demanding anything beyond good-faith evidence of their losses.

We have established a vice president with authority over environmental matters (as you point out), and we have elected to our board a distinguished scientist with extensive background in oceanographic science. We have also constituted a committee of the board to review environmental and safety practices.

We have not been reluctant to accept responsibility for these regrettable accidents or for the environmental concerns in exploring for, gathering, refining and distributing oil and natural gas. There are things we could have done differently — including the job of communicating our efforts to the news media and explaining ourselves to the public. If this has been seen as arrogance, it is, to us, a distressing impression — but in no way reflects our attitude.

L. G. RAWL
Chairman, Exxon Corporation
New York, Feb. 21, 1990

employee information

EXXON USA

20A

Houston Chronicle

Thursday, March 8, 1990

Attack on Exxon symptom of trouble

By PAUL CRAIG ROBERTS

A MERICANS have been taught to be fearful of the U.S. budget deficit, which, we are told, amounts to "mortgaging our future."

And we have been pummelled with charges of "imperial over-reach"—a claim that our military strength is sapping the life from our economy—even as we have been terrorized by hysterical claims that our food and environment are unsafe.

All the while the United States has enjoyed one of the smallest deficits in the world when measured in proportion to income and wealth. And our military rival, the Soviet Union, crippled by communism and an inefficient economy, is cracking up before our eyes.

And Americans remain the healthiest people with the safest food and least polluted environment in the world.

The unfounded hysterias that tyrannize us are calculated to serve special interests, whether those of government wanting more taxes, pacifists wanting less military or environmental groups wanting more power.

Moreover, the scare stories blind us to the real threats to our future. The most serious of these threats is the hostile attitude toward business that is being taught in our universities and law schools.

Today the U.S. government is full of young lawyers who believe that doing good in the world and at-

tacking U.S. businesses are one and the same.

For example, the U.S. Department of Justice has now turned its guns on Exxon, the largest of the oil companies.

It is absolutely certain that Exxon did not run its Valdez oil supertanker aground off the coast of Alaska on purpose in order to pollute the water and kill migratory birds. Yet the Justice Department's criminal indictment assumes that it did.

The indictment relies not on civil violations but on two laws designed to punish polluters, the Clean Water Act and the Refuse Act.

These acts make it illegal to discharge hazardous substances and refuse without a permit. They are designed under criminal law to stop people from knowingly dumping unwanted pollutants and garbage into our waterways.

It is absurd for the Justice Department to claim that the accidental spill of \$150 million of valuable oil in Prince William Sound was "refuse matter...thrown, discharged and deposited" by Exxon without a permit.

It is equally absurd to charge Exxon with violating the Migratory Bird Treaty Act, which prohibits the killing of migratory birds without a permit.

The Justice Department's lawyers need psychiatric care if they really believe that Exxon wasted \$150 million worth of oil plus \$2 billion in cleanup costs and \$180 million in damage claims paid to fishermen in order to go bird

hunting without a license.

The other two indictments are drawn from the Posts and Waterways Act and the Dangerous Cargo Act, which require tankers to be manned by competent personnel.

The government is charging that Exxon "willfully and knowingly" employed people incapable of performing the duties assigned to them.

That's about the stupidest charge imaginable. How could the attorney general possibly believe that one of the world's largest companies purposely hired incompetent people to squander its profits and jeopardize its existence.

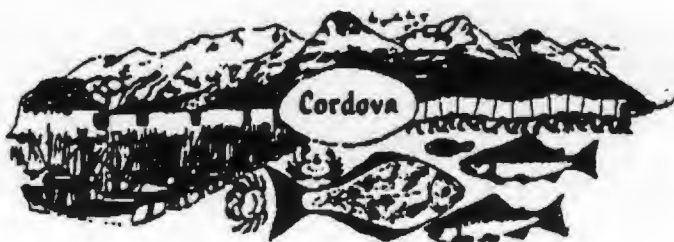
It seems clear that the captain of the Valdez supertanker didn't do his job. But he always had in the past. It is not as if he had a record of running oil tankers onto reefs while remaining in Exxon's employ.

Even those supporting the Justice Department's actions acknowledge the government faces a risky criminal trial that is based on untested legal moves.

Attorney General Dick Thornburgh has said that "by pursuing criminal charges in this case, the federal government is sending a strong signal that environmental crimes will not be tolerated."

If the government has its way with Exxon, in the future anyone involved in a car accident that results in gasoline spilling into a stream or waterway could, under the same line of thinking, be charged as an environmental criminal.

Roberts is an economist and syndicated columnist based in Washington



C. F. - Chamber of Commerce
Cordova Chamber of Commerce
First Street P.O. Box 99
Cordova, Alaska 99574
(907) 424-7260

March 20, 1990

CENTRAL FILE
OFFICIAL COPY

Mr. Monte Taylor
Exxon Company USA, Alaska Response Team
P.O. Box 240489
Anchorage, Alaska 99524-0489
Fax 907-564-3651

Dear Monte,

Thank you for your invitation to the March 15/16 briefings in Anchorage. I was pleased to be able to attend and get a better understanding of the efforts that Exxon is making to clean up the Sound and respond to other effects of the oil spill.

Thank you for the opportunity that Rose Arvidson and I had to fly out on the press tours March 18/19. We were both pleased to see how well the beaches looked and to see that life is returning to all areas with barnacles, mussels and grass starting to grow.

Rose and I reported to the Chamber membership at today's luncheon meeting. I explained how the beaches had been divided into segments and the studies that are being done to determine the best methods to restore for each segment. Rose talked about the beaches we had seen and her positive feelings about the condition of the Sound.

The Chamber board and membership continues to be appreciative of all the efforts Exxon makes to clean up the Sound as well as to respond to human needs following the spill. We reviewed some of these responses at today's meeting: the Cordova Fact Sheet, Chamber donations, child care funding, Community College funding, bunk house and tent site funding, tourism funding, employment assistance program, community liaison program, claims program, funding for CDFU, PWSAC and the City of Cordova and many other items.

Exxon has made a substantial and continuing effort to respond to the needs of Cordova residents. We appreciate your consideration and thoughtfulness.

Sincerely,

Connie Taylor, President

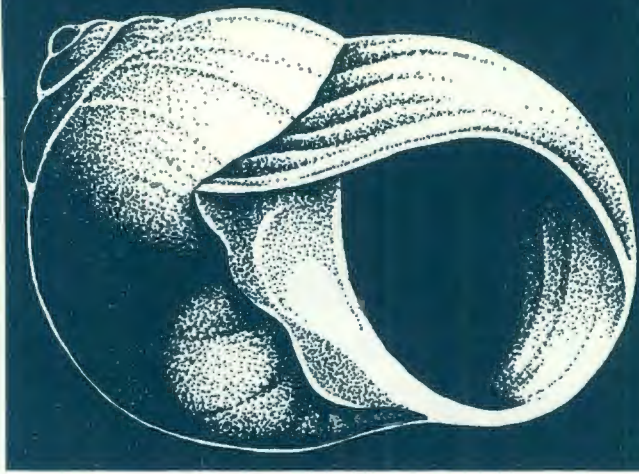
Cordova's Prince William Sound Science Center, centrally located on the southeastern shores of Prince William Sound, is a research facility established to conduct and assist basic and applied research in the Prince William Sound region of Alaska. Incorporated in April, 1989, as the Prince William Sound Science and Technology Institute, the Science Center is a private, nonprofit institution that provides an environment where scientists can work, discuss and exchange ideas in a creative and cooperative atmosphere.

For the past 15 years, Cordova-based researchers have promoted the concept of a centralized research institute in the Prince William Sound and Copper River Delta region to facilitate a deeper understanding of the biological processes at work in this unique diversity of subarctic habitats. Such a facility would serve as a base of operations, help identify research needs and act as an information repository for research conducted in Prince William Sound and the Copper River Delta.

The March 24, 1989, Exxon Valdez oil spill in Prince William Sound accelerated the need for basic and applied ecological research on the effects of oil spills in subarctic regions. Recognizing this need, a group of local scientists, representatives of the fishing industry, and city officials incorporated the Center in April 1989 as a research facility where scientists may conduct both non-oil and oil-related scientific studies. A Board of Directors provides overall policy and a Scientific Advisory Board formulates the scientific direction of the Center.

The purpose of the Center is the following:

- Provide laboratory space, equipment, and logistical and administrative support for research scientists and students.
- Assist development of a long-term environmental monitoring program for the accumulation of baseline data on Prince William Sound and its environs.
- Support other institutions and agencies conducting research in Prince William Sound and the Copper River Delta region.
- Facilitate and fund research projects in Prince William Sound and its associated drainage basins.
- Serve as a repository for scientific information resulting from research



PRINCE WILLIAM SOUND SCIENCE CENTER

C O R D O V A , A L A S K A

in Prince William Sound and the Copper River Delta region.

- Act as a host institution to the Prince William Sound Oil Spill Recovery Institute.
- Develop scientific information and education programs for students and the general public.
- Serve as an interpretive center for the general public.

The present Center, located on the dock on Breakwater Avenue, has two administrative offices, bunkhouse space for five to seven researchers, a kitchen, and a lunch room-meeting area. One-third of the 3,900-square-foot building is being converted into laboratories and a teaching facility.

Long-term, the Center plans to provide:

- Fully equipped laboratory and office facility
- Living and dining quarters for 30
- Central warehouse and smaller warehouse units for member institutions or projects
- Library
- Dock facilities
- Research vessels and field research equipment
- Classroom and other educational facilities, including an interpretive center and auditorium.

Although the Center's current emphasis is oil spill related, the original concept of creating a center to serve Prince William Sound and Copper River Delta research in perpetuity remains the pri-

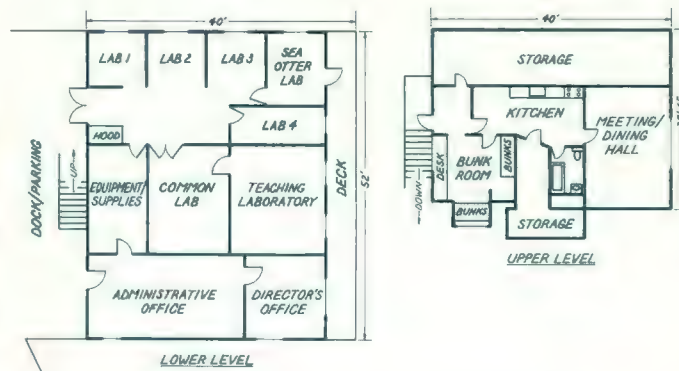
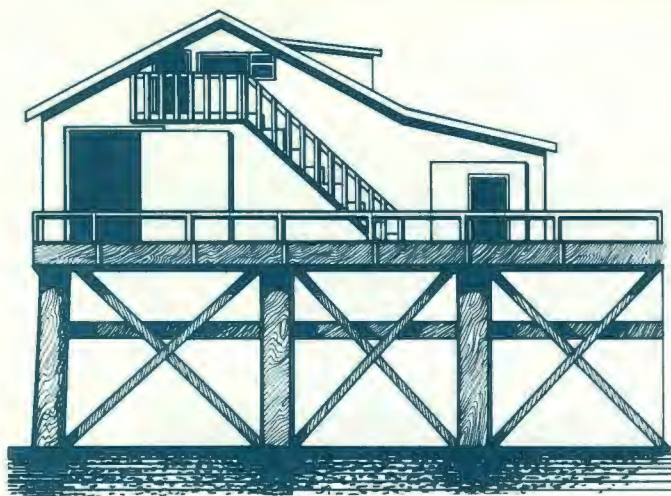
mary goal, and will re-emerge as the Center's most important function as the need for oil spill-response research lessens in decades to come.

Cordova, a community of 2,650, is economically dependent on fishing which is in turn dependent upon a healthy ecosystem. The city strongly supports the Center, not only because scientific inquiry and technological development promise to help perpetuate high quality fisheries in Prince William Sound, but also because the Center itself represents diversity, and provides further economic stability to a community primarily dependent upon commercial fishing.

The Center has also received broad support from both private and public agencies, many of which are conducting post-spill research activities in Prince William Sound out of Cordova. These agencies have found Cordova to be the most logical base of operations because of its proximity to oil-impacted areas of the Sound, its proximity to the rich flats of the Copper River Delta, its role as a hub of commercial fishing activity (it is the nation's ninth largest fishing port by value), and its facilities, which include a modern airport and hospital.

The Prince William Sound area has long attracted researchers in both the basic and applied sciences because of its habitat diversity and natural resource wealth. At 15,000 square miles, Prince William Sound, a relatively deep, glacially-

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DP



Prince William Sound Science Center

carved fjord, is about 15 times the size of San Francisco Bay. In addition to being one of the world's richest herring and salmon fisheries, its waters and 3,000 miles of shoreline support tremendous numbers of sea birds and marine mammals.

In addition, PWS is adjacent to the Copper River Delta which is the largest contiguous wetland in the western United States. The two million acres of marshland, rivers, streams and ponds of the Delta are home to millions of waterfowl, shorebirds, salmon, trumpeter swans, moose, bear, wolves and many other species of wildlife. The Delta is the only known breeding area for dusky Canada geese and supports more than 11 percent of the world population of trumpeter swans. The USDA-Forest Service recognizes the need for researchers to study this rich wetland habitat and has established the Copper River Delta Institute in Cordova for that purpose. The Science Center will work closely with the Delta Institute to coordinate research and education efforts.

The waters of Prince William Sound support one of the nation's richest combination of salmon and herring fisheries, with an ex-vessel value of about \$85 million in 1988. Other important fisheries include dungeness crab, shrimp, halibut and other groundfish. Five major salmon hatcheries operate in the Sound. Three of

those are managed by Prince William Sound Aquaculture Corporation, including the world's largest hatchery at Esther Island.

The Sound is home water to some of the world's densest populations of sea otters and killer whales, which together with other cetaceans, seals and sea lions represent one of the more profuse populations of marine mammals anywhere.

Two hundred and forty species of birds — including waterfowl, raptors, seabirds, shorebirds and songbirds that aggregately number in the tens of millions, are found in Prince William Sound. The bird populations notably include about 3,000 bald eagles, and about a dozen major seabird colonies.

The Science Center's primary goal is to facilitate research that increases the understanding and knowledge of the biological, chemical and physical processes at work in the unique subarctic environment of southcentral Alaska. A better understanding of these processes will benefit resource managers and the general public by providing essential information for the continued health and diversity of Prince William Sound and the Copper River Delta.



Prince William Sound
Science Center
Box 705
Cordova, Alaska 99574
(907) 424-5800
FAX (907) 424-5820

Daily flights to Anchorage, Juneau and Seattle

Air miles to Anchorage — 250 miles/40-minutes direct flight

Air miles to Juneau — 411 miles/2-hour flight with one stop

Air miles to Seattle — 1,293 miles/5-hour flight, 2 stops

Cordova is also accessible by ferry from Valdez, year-round, and from Whittier in the summer months. The ferry operates 2-3 times per week.



WETLANDS RESEARCH UPDATE

Prepared by Richard Sumner

February 1990

Eric M. Preston, Technical Director
Wetlands Research Program

This Update has been prepared to keep those who are participating, cooperating, or interested in the U.S. Environmental Protection Agency's Wetlands Research Program (WRP) abreast of our activities and accomplishments. It describes the status of the various wetland research efforts, recent publications and other information transfer activities.

WETLANDS CREATION AND RESTORATION

The approaches, successes, and inherent risks in restoring or creating particular wetland types and functions are discussed in a recently published WRP report entitled "Wetlands Creation and Restoration: The Status of the Science" (See Kusler and Kentula 1989 in Program Publications section). Wetlands creation and restoration information was assembled from as many sources as possible, including personal experience. The resultant synthesis provides technical assistance to those individuals responsible for the design of creation and restoration projects. The document also is a first step in providing wetlands regulators with an analytical framework to build criteria for wetlands creation and restoration. The "Status of the Science" report is being distributed by the EPA, CERI (G-74), Document Tracking Coord., Cincinnati, OH 45268. A printing of the document by Island Press is planned in May 1990.

As a follow-up to its publications of 1989, the WRP will begin preparation of a handbook on wetlands creation and restoration. Technical guidance will be drafted as results from the Program's ongoing wetland creation studies are synthesized and reported. For example, to provide a better framework for making wetland regulatory decisions, a tracking system was developed to describe trends and patterns in wetland permitting. Results from Washington and Oregon have been reported. Results from Louisiana, Texas, and California will be reported in 1990.

Study of permit records documents wetland impacts

The 323 federal permits requiring wetland creation or restoration in California (1971-87) document impacts to 368 wetlands and the creation of 387 wetlands. There was a net gain of 195 wetland acres. Estuarine and palustrine wetlands were impacted and created most frequently. The wetland type created often differed from that impacted. This caused local gains and losses of specific wetland types.

The 228 permits involving freshwater wetlands in Louisiana (1982-87) document impacts to 260 wetlands and the creation of 118, resulting in a net loss of 26,090 wetland acres. Wetland types most often impacted and created were palustrine forested and palustrine emergent.

Field studies of created wetlands are being conducted to improve methods of creating, restoring, and enhancing wetlands and to develop methods for describing and evaluating natural and created wetlands. Reports on studies in Oregon, Connecticut, Iowa, and Florida will be available in 1990. New cooperative studies with the EPA Regions and the States will be initiated.



United States
Environmental
Protection Agency

Environmental Research
Laboratory--Corvallis
Corvallis, Oregon 97333

Field studies document discrepancies in wetlands creation work

Ten created, palustrine emergent wetlands were studied in Oregon. Comparison of areas of created wetlands measured in the field with those listed in the Corps of Engineers permit conditions indicates that none were constructed as permitted. The permit conditions specified the creation of a total of 12.6 acres of wetland. The cumulative difference between the area of wetland required in the permits and the field measurements was -3.9 acres or a 29% loss. Therefore, there was a cumulative loss of wetland area from the amount that was to be mitigated. In addition, only 18% of the species on planting lists were found on the sites. This suggests that the majority of the species planted do not survive. However, due to the lack of "as-built" information, it can not be determined if either the plants do not persist or were not planted.

For more information on wetlands creation and restoration research, contact Mary Kentula at (503) 757-4666 or FTS 420-4666.

CUMULATIVE IMPACTS

The overall objective of WRP's cumulative impacts project is to provide technical guidance to wetland regulators on assessing cumulative impacts to wetlands, along with the consequent effects of wetland alteration on landscape function. The intent is to complement current review and assessment practices with procedures that provide regional (landscape level) context for individual decision-making. The project includes three research components: (1) development of a conceptual foundation and theory, (2) validation of the theory through landscape studies, and (3) development of assessment methods based upon the theory.

The quantitative model being developed by WRP will explicitly formulate hypotheses about landscape and wetland processes, and provide an analytical framework for testing these hypotheses. The process-oriented model will account for ecosystem interactions, landscape function, and environmental impacts. Two types of impacts are addressed in the model: conversion (e.g., agricultural filling of wetlands) and degradation (e.g., impairment of wetland function by chemical contamination). Formulation of the model is nearing completion. A manuscript is scheduled to be submitted for publication in May 1990.

An empirical landscape analysis in the State of Illinois will expand the basic understanding of how wetland function contributes to the landscape. The study, entitled "Cumulative Effects of Illinois Wetlands on Landscape Function," also will help test the assumptions made in the WRP landscape model. The analysis will use multivariate statistical techniques to test hypothesized dependencies between landscape functions and the extent, type, position, and pattern of wetlands. The effect of landscape and wetland attributes on indicators of regional hydrology, water quality and life support will be examined for 60 watersheds.

A synoptic approach to cumulative impact assessment is being developed for use in routine wetland permit actions. The approach is based upon the relative ranking of watersheds within a study area, using six indices of hydrology, water quality, and life support function. These indices are landscape input, wetland capacity, cumulative impacts, landscape sensitivity, landscape risk, and wetland significance. Estimation of the indices involves the collection of readily available mapped and tabular data, analysis of the data resulting in a set of primary map overlays, and a combination of the overlays to produce the final mapped indices.

A paper describing the synoptic approach has been submitted for publication. Statewide applications of the method, specific to the advancement of wetland water quality standards, are being conducted in cooperation with the States of Louisiana and Washington.

For more information on cumulative impacts research contact Scott Leibowitz at (503) 753-6221 or FTS 420-4666.

WATER QUALITY

The wetlands water quality program has been designed to build a technical foundation for state wetland water quality standards. Projects will provide information to further two objectives:

1) Determine the waste assimilative capacity of wetlands, and 2) develop criteria to protect wetland function. The first objective will be met by both process-oriented and empirical studies.

A series of process-oriented studies of a number of critical wetland types are proposed. Similar approaches, based upon the pollutant dosing of mesocosms placed in natural wetlands, will be used in all studies to allow comparisons to be made among wetland types. The first of these studies will begin this spring under a cooperative agreement with Louisiana State University. Mechanisms involved in regulating wetland assimilative capacity for nutrients, heavy metals and synthetic organic substances will be studied in a bottomland hardwood forest setting. A range of experimental scales will be used: laboratory microcosms to investigate detailed chemical processes, field mesocosms to investigate effects on indicators of wetland health, and undisturbed wetlands to verify the microcosm and mesocosm results. The assimilative study will continue for two years and will produce estimates of the wetland carrying capacity for the selected substances.

The process-oriented studies will complement an empirical study now in progress under a cooperative agreement with the University of Minnesota, Duluth. The purpose of this study is to determine the effects of disturbance on the water quality functions of wetlands. Wetland water quality is being monitored prior to and following disturbances, such as filling, draining, stormwater inputs, and applications of pesticides. An initial assessment of the pre-disturbance water quality and landscape characteristics has been made. Changes in water quality following disturbances will be monitored and related to the landscape characteristics that mediate these effects. Results will be important in predicting how permitted actions are likely to affect the water quality function of wetlands.

Initial research to develop water quality criteria for wetlands will involve an analysis of the applicability of current EPA Water Quality Criteria to wetlands. The EPA Water Quality Criteria were developed for surface waters. The direct application of these criteria to wetlands is questioned because of the very different conditions found in wetlands relative to the test conditions used in establishing the criteria. Current surface water criteria will be reviewed, and those that have direct application will be recommended for use in wetlands regulation.

For more information on water quality research, contact Bill Sanville at (218) 720-5723 or FTS 780-5723.

CONSTRUCTED WETLANDS

"Constructed Wetlands" is a new research theme area for 1990 in the WRP. Constructed Wetlands are wetlands engineered to solve particular water quality problems. They are distinguished from wetlands that are created or restored as compensation through wetlands regulation. Constructed Wetlands research historically has pioneered the use of wetlands and aquatic plant systems for municipal wastewater treatment and acid mine drainage. Currently, the Wetlands Research Program and EPA's Risk Reduction Engineering Laboratory in Cincinnati are exploring other applications, such as the potential ecological consequences of applying this technology to solve point and nonpoint source pollution problems.

Work has begun to identify the role the Wetlands Team will play in assessing and improving the effectiveness of constructed wetlands. A cursory survey of current research suggests there exists an excellent opportunity to cooperate and collaborate with the Tennessee Valley Authority (TVA) and the U.S. Soil Conservation Service on this topic.

For more information on the Team's constructed wetlands research, contact Richard Olson at (503) 753-6221 or FTS 420-4666.

ENVIRONMENTAL MONITORING AND ASSESSMENT PROGRAM (EMAP)

The Wetlands Team is assisting the planning phase of the Agency's recently initiated Environmental Monitoring and Assessment Program (EMAP). The primary objective of the Wetlands component of EMAP is to determine the status and trends in ecological condition of the Nation's Wetlands. The Team has been addressing both 1) statistical design issues and 2) the identification of potential indicators for determining wetland health. To date, design and indicator draft reports have been prepared for this project.

For more information on the Team's EMAP research, contact Nancy Leibowitz at (503) 753-6221 or FTS 420-4666.

TECHNICAL INFORMATION TRANSFER

As part of our technical information transfer activities over the last few months, the Team:

- o hosted a cumulative effects workshop in Baton Rouge, Louisiana. The workshop served to update Louisiana State wetland managers and EPA wetland managers on the Program's research efforts. Technical discussion focused upon (1) a pilot application of the Synoptic Approach in Louisiana, and (2) an integration of assessment methods being developed by the Program and by Dr. James Gosselink of Louisiana State University.
- o offered a presentation at an EPA Region 10 sponsored workshop in Seattle, Washington entitled "Wetlands and stormwater/wastewater management."
- o hosted a series of meetings with a delegation of research scientists from the Soviet Union. A cooperative wetlands research venture involving EPA's Environmental Research Laboratory, Duluth was initiated.
- o initiated a study to focus upon the waste assimilative capacity of surface waters and wetlands.
- o offered two presentations at the May 30-June 2, 1989 meeting of the Society of Wetland Scientists. The papers presented were entitled, "The effects of disturbance on water-quality functions of wetlands: a regional assessment" and "The effect of wetlands on lake water quality: a landscape approach."
- o offered a presentation at the 62nd Annual Conference of the Water Pollution Control Federation entitled, "Landscape effects on water quality."
- o began preparation of a special session on cumulative effects for the upcoming June 4-6, 1990 meeting of the Society of Wetland Scientists in Breckenridge, Colorado.
- o began preparation of a special session on evaluating created wetlands for the upcoming June 4-6, 1990 meeting of the Society of Wetland Scientists in Breckenridge, Colorado.

PROGRAM PUBLICATIONS AND CITED LITERATURE

Adamus, P.R. 1989. The U.S. Environmental Protection Agency's Inland Wetlands Research Program. Coastal Society Bulletin 12(3):8-11.

Adamus, P.R. 1989. Wetlands and Water Quality: EPA's Research and Monitoring Implementation Plan for the Years 1989-1994. USEPA Environmental Research Laboratory, Corvallis, Oregon. 44pp.

Kentula, M.E. In press. Wetlands Evaluation II: The extensive approach—EPA's research program and the investigation of an extensive sampling approach to comparing created and natural wetlands. IN: Proceedings of the First Annual Meeting of the Society for Ecological Restoration, January 16-20, 1989, Oakland, California.

Kusler, Jon A. and Mary E. Kentula (Eds.). 1989. Wetland creation and restoration: The status of the science. Volume I: Regional Reviews. Volume II: Perspectives. EPA/600/3-89/038a,b, Environmental Research Laboratory, Corvallis, Oregon.

Personnel Notes

We welcome Richard Olson to the Wetlands Research Program. Richard joins the Team after four and one-half years with Corvallis Laboratory's Forest/Acid Rain Team where he was Director of the Western Conifers Cooperative. His expertise in ecosystem nutrient cycling and program management will be important in building a role for the Team in constructed wetlands research.

If this Update was mailed to you, you're on our mailing list and will continue to receive Program information. Please pass it to anyone we may have missed and notify us if you change your address.

If you wish to be added to our mailing list, or want further information on the Wetlands Research Program, contact Richard Sumner, EPA Environmental Research Laboratory, 200 SE 35th Street, Corvallis, OR 97333, (503) 753-6221, or FTS 420-4666.

UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY
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CORVALLIS, OREGON 97333

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Puget Sound Notes

October, 1987

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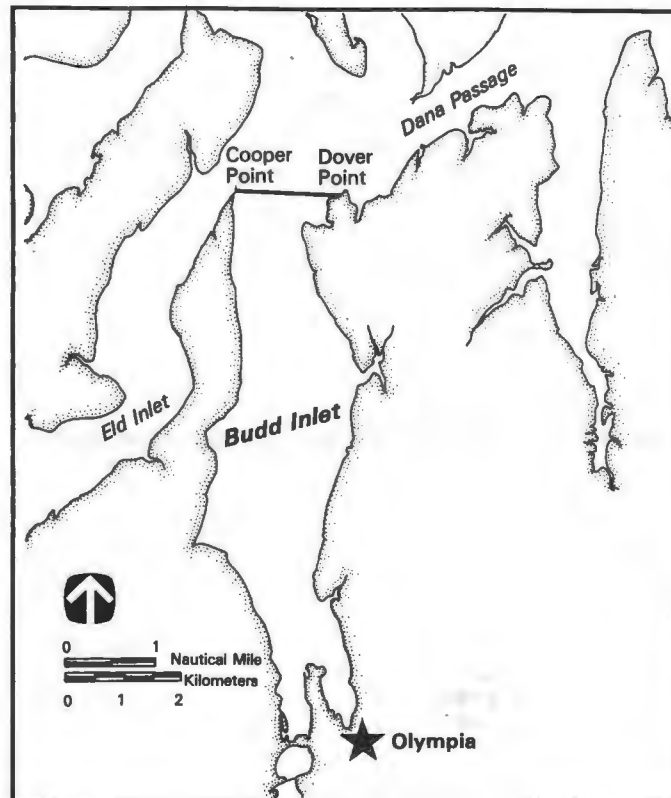
Budd Inlet Problem Identification Work to Begin

The Office of Puget Sound at U.S. EPA Region 10 and the Department of Ecology are currently sponsoring the development of Toxics Action Programs for several urban embayments throughout Puget Sound. The goal of the action programs is to protect the marine and estuarine ecosystems against further degradation associated with man made inputs of pollutants. Budd Inlet has been identified as a priority area for problem identification, which is the first step in the development of a Toxics Action Program.

Budd Inlet is located in Southern Puget Sound, with the city of Olympia located near the southern end of the inlet. Soil, ground water and sediment contamination problems at Cascade Pole, a pole treating plant, have prompted initiation of the problem identification investigation.

The objectives of the present work are to compile and evaluate available data, evaluate problem areas based on preliminary action level criteria, and identify data gaps. The results of this work will be incorporated into a draft report on Initial Data Summaries and Problem Identification for Budd Inlet. The report will contain: 1) the results of an analysis of available literature and data on contamination, biological impacts, and contaminant sources; 2) application of existing criteria to identify problem areas; 3) a discussion and ranking of problem areas; and 4) a summary of additional data needs. Upon completion of the Initial Problem Identification, the next steps in development of the Toxics Action Program are to develop an Interim Action Plan. Based on the results of the Problem Identification and if funding is available, a final Action Plan will be developed and an action team formed to carry out corrective actions in Budd Inlet. A work group and citizens advisory group have been convened to help direct and oversee the study.

Budd Inlet Study Area



New Office of Puget Sound Chief Appointed



Jack Gakstatter, a veteran scientist with EPA's Office of Research and Development, this summer became the new chief of EPA's Office of Puget Sound at the agency's regional headquarters in Seattle. He replaces John Underwood, who retired at the end of July.

In the 21 years since he earned a doctorate in environmental chemistry and biology from the University of North Carolina, Jack has devoted most of his career - from 1972 to 1986 - to work as a supervisory aquatic biologist at EPA's Environmental Research Laboratory at Corvallis.

Other experience in Jack's background includes four years as a limnologist and lab manager with the state of Iowa, and two years as a research aquatic biologist with the Federal Water Pollution Control Administration's laboratory in Athens, Georgia.

Jack has worked in EPA's regional headquarters in Seattle since 1986, when he assumed duties as the Office of Research and Development liaison with the region.

Research Projects Nearing Completion at Padilla Bay

Several research projects are underway and nearing completion at the Department of Ecology's Padilla Bay National Estuarine Research Reserve located west of Mt. Vernon in Skagit County. The projects are part of a comprehensive research program examining the value and function of estuarine habitats.

The "Remote Sensing Inventory of the Seagrass Meadow" study, funded by the National Oceanic & Atmospheric Administration (NOAA), is a cooperative effort between researchers at Western Washington University, the Department of Natural Resources and Seattle Pacific University. This study will develop a method to inventory and monitor seagrass meadows using satellite data (Landsat 5 TM). Ground-truthing field work detailing the density and distribution of eelgrass will be correlated with satellite imagery data. A final report is scheduled for completion in November, 1987.

Investigators from the Fisheries Research Institute (F.R.I.) at the University of Washington are conducting several studies:

"The Importance of Primary Producer Habitats to Estuarine Food Webs", funded by the Washington Sea Grant Program and NOAA, is exploring the importance of primary producer habitats to key consumers by: 1) measuring changes, over time and space, in the naturally occurring stable carbon and nitrogen isotope composition of phytoplankton and plants in estuarine habitats; and 2) measuring the carbon and nitrogen isotopes in mussels as well as mussel growth in different habitats to determine the effect of food resources on sessile bivalve growth. This study is scheduled for completion in December 1987.

"Assemblage Structure, Microhabitat Distribution and Food Web Linkages of Epibenthic Crustaceans", funded by NOAA, brings together investigators from the University of Washington, the Department of Fisheries and the Department of Ecology. This study seeks to describe, among other things, the relationship between habitat and the diversity of crustacean groups and the occurrence of specific prey groups in stomachs of nearshore predators (e.g. fish, crab, shrimp) indicating habitat-specific foraging. Study completion is scheduled for December, 1987.

NOAA is also funding "Production Rates of Two Seagrass Systems in Padilla Bay", an assessment of the contribution of two species of eelgrass (*Zostera marina* and *Zostera japonica*), to total primary production in Padilla Bay. Seasonal variations in production and the effects of light, temperature and depth

also will be addressed. This study is scheduled for completion in November 1987.

Final results and reports from these studies will be on file at the Breazeale-Padilla Bay Interpretive Center, 1043 Bayview-Edison Road, Mt. Vernon, WA. For more information on estuarine research at the reserve, contact **Terry Stevens**, reserve manager at (206) 428-1558.



Investigators set up a station for mussel cages on Padilla Bay's mudflats for the Primary Producer Habitats study.

Photo by Charles Simenstad

Puget Sound Monitoring Plan Review

The draft Puget Sound Monitoring Plan is now available for public review. The Water Quality Authority will hold a workshop on October 8th at 7:00 p.m. at the Federal Way Public Library, 848 S. 320th in Federal Way. This workshop will provide an opportunity to learn more about the proposed program and make comments. If you are interested in attending the workshop, call 1-800-54-SOUND.

The Monitoring Management Committee, created as a result of the Puget Sound plan, has been working for nearly a year on the draft program. The committee has proposed a comprehensive ambient monitoring program to provide baseline and long-term data to detect changes over time.

The program includes monitoring water, sediments, fish, shellfish, birds, marine mammals and other resources. Samples will be taken annually at some sites while other locations would be sampled on a monthly or quarterly basis. Citizen volunteers would play an important role in the monitoring program.

\$1 Million Public Involvement/Education Fund

The Puget Sound Water Quality Authority is sending out the first round of requests for proposals for model projects to educate and involve the public in the cleanup and protection of Puget Sound.

The purpose of the fund is to encourage projects related to issues in the Puget Sound plan. The first round of proposals calls for projects in the following categories:

- Citizen Monitoring
- The Sound as a whole
- Watershed awareness
- Decision Makers and decision points
- Business and Industry
- Teacher training
- Wetland protection

It is expected that 15 to 20 projects will be funded, generally in the \$10,000 to \$50,000 range. The remainder of the fund will be awarded through a second round of requests for proposals next spring.

A packet of guidelines and requests for proposals can be obtained by calling 1-800-54-SOUND. Deadline for submittal of proposals is November 6, 1987.

Toxicant Reduction in the Denny Way Combined Sewer System

By **Pat Romberg, Denise Healey, and Keith Lund**
Industrial Waste Section, Water Resources Section
Municipality of Metropolitan Seattle

Abstract

Combined sewer overflows (CSOs) are a source of pollution to receiving waters and need to be controlled. A new Facilities Plan adopted by the Municipality of Metropolitan Seattle (Metro) includes many large construction projects that will provide secondary treatment and reduce discharge volumes for CSO sites. The Denny Way CSO, which discharges large volumes of untreated wastewater into Elliott Bay, is a major concern without a quick solution.

As an interim approach to improving environmental conditions at Denny Way CSO, Metro conducted a trial study aimed at identifying and reducing toxicant inputs into the sewer system tributary to the CSO.

Introduction

A combined sewer is one that receives both sanitary sewage plus stormwater runoff from streets and gutters. Combined sewer systems were built in Seattle (and most other large cities) at a time when the primary objective in wastewater control was to simply collect and transport those flows to nearby water bodies without providing any treatment. However, when receiving waters developed severe pollution problems, it became necessary to build facilities to intercept and transport wastewater flows to treatment plants. Due to cost and various practical limitations, these facilities were designed to handle only the projected sanitary flow rather than the peak combined flows. Since runoff from large storms could overload the system, a series of overflow relief points (CSOs) were included along the lines so excess volumes could be diverted directly to receiving waters without treatment.

During the 1960's Metro built the present system of interceptors and treatment plants that collect, transport and treat wastewater in the greater Seattle area. The West Point primary treatment plant receives wastewater flows from these large interceptors and discharges the treated effluent to Puget Sound. West Point is designed to handle a base flow of 125 million gallons per day (mgd) with a peak wet weather capacity of 325 mgd. There are approximately 100 relief points in the system, with 25 CSO sites that overflow at least once per year.

During high flow conditions, a Computer Augmented Treatment and Disposal (CATAD) system maximizes inline storage and regulates where overflows occur. This system is programmed to minimize overflows to the more sensitive fresh water bodies and gives priority to discharging into marine waters. As a result, over 50 percent of the total overflow is discharged into Elliott Bay, 20 percent goes into the Duwamish River estuary, 20 percent is discharged to Lake Union and the Ship Canal, and less than one percent overflows into Lake Washington.

The Denny Way CSO and Drainage Basin:

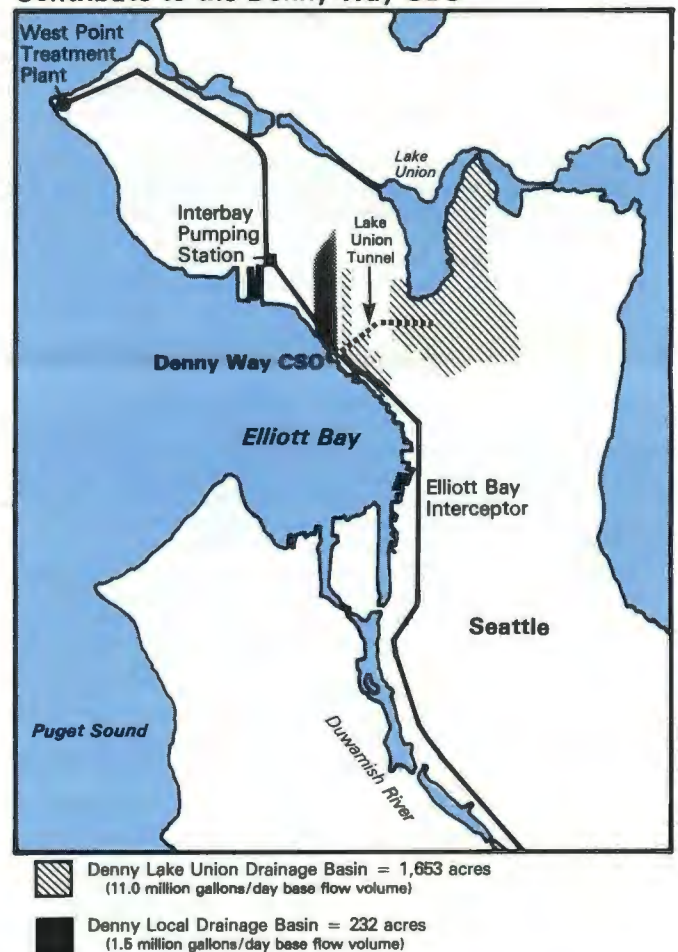
The largest and most frequent overflow site on Elliott Bay is the Denny Way CSO. During wet years (1981-1983) total overflow volume can average 500 million gallons a year. About 99 percent of this volume originates from two specific drainage basins called Denny Way Local and Denny Way Lake Union. (Fig. 1)

Between 1895 and 1969, these two basins each had a separate discharge line that continually discharged untreated wastewater directly into Elliott Bay. When Metro built the Elliott Bay interceptor line in 1969, these two discharges were plumbed into the Denny Way regulator. Here, flows from each area can be controlled separately and routed either into the interceptor or into Elliott Bay when the interceptor is full. The CATAD control raises the regulator gates to store as much volume as possible in the local lines before diverting this flow into Elliott Bay. Diversion here and at other regulators allows the interceptor to be maintained at a full level without backing

Denny Way was chosen because it is the largest CSO discharging to Elliott Bay and has been identified as a major source of substantially elevated levels of toxicants in bottom sediments near the overflow site.

Part of the study focused on commercial businesses and involved a questionnaire survey and site visits to obtain information about the use and disposal practices for toxic chemicals. Separate sampling programs were conducted both in the sewer system to identify chemicals and their sources, and in the offshore sediments to define existing conditions. The study concluded that toxicant reduction projects can reduce chemical inputs into Elliott Bay.

Figure 1
Location and Size of the Two Drainage Basins that Contribute to the Denny Way CSO



up and overflowing itself. When levels in the interceptor begin to drop, CATAD adjusts the regulator gates to start redirecting local flows back into the interceptor.

Assessment of environmental problems has played a key role in decisions about discharging untreated wastewater off Denny Way. Problems with sewage in Lake Union and sewage overflowing in streets during rainstorms prompted construction of two diversion lines and outfalls to Elliott Bay in 1895. Subsequent concern over high fecal bacteria levels in Elliott Bay and even greater bacteria and nutrient problems in Lake Washington led to major construction projects that eliminated all continuous untreated wastewater flows from Elliott Bay in

1969. This action greatly improved conditions, but in a few years a new concern developed over whether CSO discharges were causing toxic effects in the environment.

For several years various studies were conducted around the Denny Way CSO to look for environmental effects. These studies showed that bottom sediments near the outfall contained substantially elevated levels of heavy metals and organic toxicants and that there were detectable biological effects in the form of altered benthic communities. While these studies were unable to establish a clear "cause and effect" relationship between elevated chemicals and biological effects, the strong correlation was convincing enough to indicate a need for action. Metro's primary strategy for controlling the Denny Way CSO is to reduce the frequency of overflow events from more than 50 to less than 10 per year through partial separation in the Denny Local/Lake Union basin. Reduction of toxicant inputs to the CSO drainage basins is a supplemental activity that can also provide environmental benefits and will be pursued when feasible.

Identification of Toxicant Sources:

In October 1986 a questionnaire survey was sent by mail to those businesses that were considered potential toxicant sources to Denny Way CSO. This survey was designed to:

- Provide an estimate of how much wastewater originates from commercial sources.
- Identify what types of chemicals are currently being discharged or stored by these businesses.
- Serve as a basis for selecting those businesses that should be investigated more closely through site visits and those that can be designated as having no significant discharge.
- Increase public knowledge about the CSO discharge problem and the fact that steps must be taken to improve the situation.

Various business categories that were considered potential toxicant sources were selected for the survey based on Standard Industrial Classification (SIC) codes. The categories included everything from services and light manufacturing to more industrial activities such as electroplating and industrial laundries. A computer data base containing addresses of all Seattle area businesses with the selected SIC codes was purchased. This master data base was then sorted by address to yield a list of 530 target businesses tributary to Denny Way CSO. The list contained a large number of photodeveloping operations and printing shops that were sent different questionnaires than the general business categories.

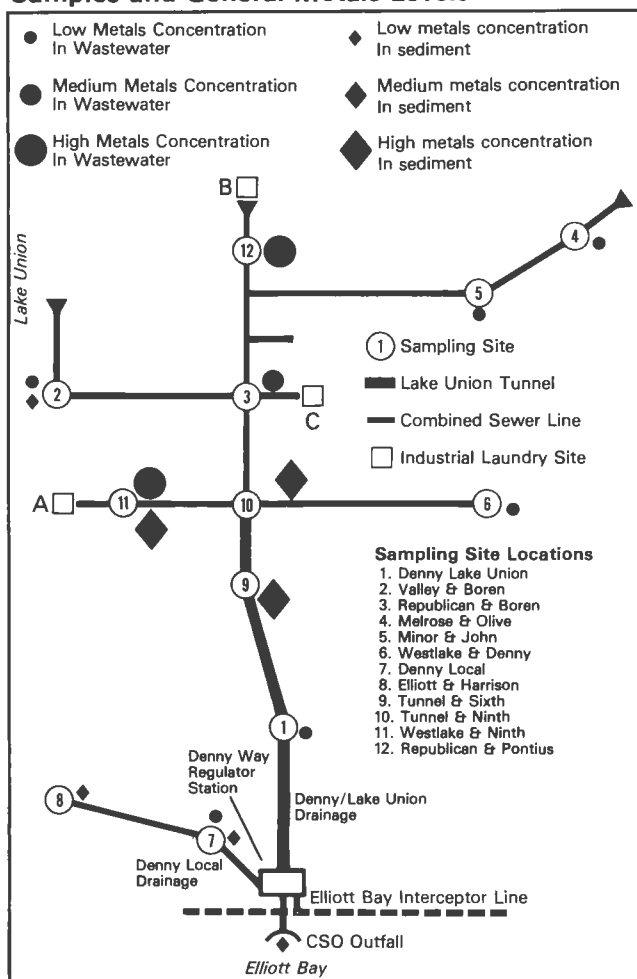
Total response to the survey reached 54 percent. Nearly all businesses that failed to respond were visited or contacted by phone and in all but a few cases none of these had any discharge and felt there was no need to respond to the survey.

The survey results indicate that only a portion of the many commercial businesses in the area have any discharge other than sanitary flow and that the total non-sanitary flow from these businesses is only about four percent of the combined average base flows for the two drainage basins (12,600,000 gallons per day). Three businesses in these basins were already regulated by a Metro industrial discharge permit, and they represent about two percent of the four percent total. These businesses include two industrial laundries that each discharge 100,000 gallons per day and an electroplating operation with a discharge of about 3,000 gallons per day. All the other commercial sources combined make up the other two percent of the total.

Site visits

Selected businesses were visited during December 1986 by a Metro industrial waste investigator. Limited staff and time constraints made it impossible to inspect every business in the study area, so inspections were carried out at a number of companies representative of the various business categories. The types of businesses visited included dry cleaners, print

Figure 2
Location of In-Line Sediment and Wastewater Samples and General Metals Levels



shops, photo processors, medical laboratories, auto repair shops and other manufacturing operations.

A total of 96 site visits were conducted and 71 percent of the companies visited had discharges to the sanitary sewer. Storage problems were observed at 20 percent of the locations visited. Letters requesting improvements and/or permit applications were sent to 42 percent of the companies.

Site visits confirmed that most discharge volumes were small, as was reported in the questionnaire survey. A total of 70 businesses were in the lowest discharge category of less than 50 gpd while 19 were in the 50-100 gpd category and only 3 were in the more than 500 gpd category.

Collection System Samples and Results

Wastewater and in-line sediment deposits were sampled during May and October of 1986 (Figure 2). Wastewater samples were taken at nine locations (sites 1, 2, 3, 4, 5, 6, 7, 11 and 12). Sediment samples were collected at six sites (sites 2, 7, 8, 9, 10 and 11). Samples were analyzed for both metals and organic priority pollutants.

Of the wastewater samples, six had relatively low metal concentrations that were similar between sites and represented a fairly uniform baseline condition. Three sites (3, 11, and 12) had higher levels of most metals. This appears to be due to inputs from upstream industrial laundry sources labeled A and B in Figure 2. Lead and chromium were elevated at site 6. A second sampling showed an even higher chromium level. Site investigations traced the chromium source to a movie film developing operation. This source has been directed to use proper disposal practices and the input should be eliminated or greatly reduced. Sites 1 and 7, located just upstream from the Denny Way regulator, showed overall low

concentrations that were similar during two sampling events.

The in-line sediment samples contained much higher levels of metals than the wastewater samples. This was to be expected since sediments represent a concentrated sample of the particulates that are present in the wastewater sample. Highest metals values in sediments were found at site 11, which is not far downstream from an industrial laundry operation. Other high metals concentrations were found at sites 9 and 10, which are located farther downstream from the laundries at the upper end of a six foot diameter conveyance tunnel called the Denny Lake Union tunnel. Sediment has accumulated up to 2 feet deep in the upper portion of this tunnel and could total about 90 cubic yards of sediment that needs to be removed. Concentrations at both tunnel sites were fairly similar except for lead and copper which were higher at the downstream site. Although concentrations in the tunnel were relatively high, they were substantially lower than those values found near the laundry at site 11. Zinc, lead, nickel, copper and cadmium were all four to six times higher at site 11, and chromium was twice as high.

Sediment concentrations at sites 2, 7 and 8 were much lower than those found in the tunnel (sites 9 and 11) and appear to represent a baseline condition for sediments. The sample at site 8 was taken from a catchbasin and had slightly higher concentrations of metals than in-line sediments collected at sites 2 and 7. In general, in-line sediments taken from sites isolated from the laundries had concentrations many times lower than those found in the tunnel (7 times lower for zinc and chromium; 35-90 times lower for cadmium, copper and lead).

These results strongly indicate that particulates from the laundries (which are reflected in the tunnel values) have a much greater influence on offshore sediments than do particulates from the Denny Local system. This conclusion is further supported by the fact that concentrations of lead and mercury in the Denny Local sediments (sites 7 and 8) are lower than the values found in offshore sediments.

Offshore Sediment Samples and Results

Grab samples of offshore sediment from a grid of 29 stations showed that surface sediment concentrations for heavy metals were far more uniform than organic pollutant values both in terms of the overall concentration range and distribution patterns. Heavy metals and organic PAHs had distribution patterns similar to that of lead shown in Figure 3, but PCBs were very patchy with no clear pattern. Sediment concentration values decrease more rapidly with distance offshore (increasing depth) than they do with distance along shore. Despite certain anomalies, the general distribution pattern tends to be fairly symmetrical both north and south of the outfall structure.

Sediment core data presented in Figure 4 provides historic information on how concentrations of lead and copper have changed over time. Values in the upper part of each core reflect conditions resulting from Denny Way CSO discharges since 1969. Stations 7 and 19 are near the old raw sewer outfalls and high concentrations deep in the cores are due to these historic discharges. The drop in concentrations midway down the cores appear to be caused by construction of the Denny Way regulator along the waterfront which reduced wastewater flows and added cleaner soil into the sediments to reduce concentrations for a time.

Conclusions and Recommendations for Toxicant Reduction

While industrial laundries appear to be the major source of metal laden sediments that have accumulated in the past, installation of new pretreatment equipment was implemented in 1986 which should reduce these inputs in the future. Only a preliminary estimate of these reductions is possible since the new pretreated discharges have only been sampled once. Based on this data, estimated average daily loadings for lead, copper and zinc were calculated for the two laundries presently in operation and compared with their average loadings for 1980-1985 before pretreatment. This comparison is presented in Table 1.

Figure 3
Distribution Plot of Lead Concentrations in Surface Sediments

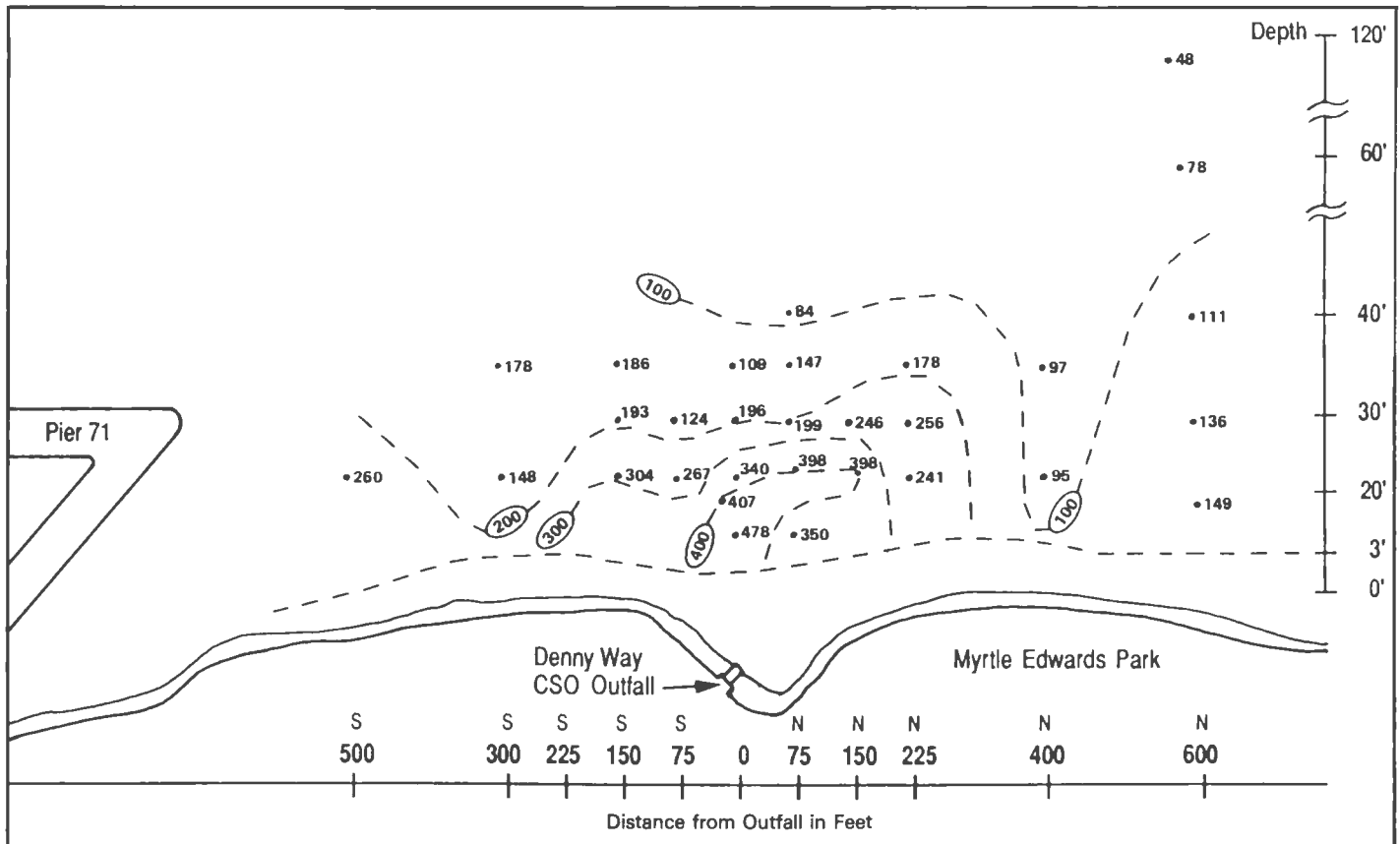
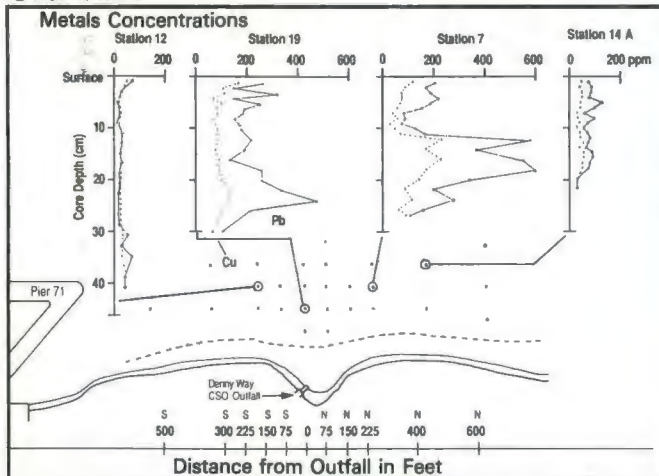


Figure 4
Sediment Coring Locations and Vertical Profiles of Lead and Copper Concentrations Showing Change Over Time



Lead showed an exceptionally large reduction of 77 percent, while copper and zinc also show substantial reductions of 50 and 24 percent respectively. These figures do not include the loading attributable to Laundry C, which ceased operation in mid-1985. When Laundry C's pre-1985 load is included in the calculation, load reductions for laundry sources are even greater at 81 percent for lead, 56 percent for copper and 38 percent for zinc. Volatile organic compounds have been reduced even more than the metals.

Commercial sources (excluding industrial laundries) appear to be a minor source of wastewater discharged to the system, comprising only one or two percent of average dry weather flow. The drainage basin was found to contain over 500

Table 1
Discharge of Metals from the Industrial Laundries
 (1980-85 Data vs 1986 Data to Show Influence of Pretreatment)
 (Loading Values are in Pounds per Day)

Laundry	Copper	Lead	Zinc
	80-85/86	80-85/86	80-85/86
A	0.6/0.2	2.5/0.3	1.1/0.9
B	1.4/0.8	4.2/1.2	3.4/2.5
Total	2.0/1.0	6.7/1.5	4.5/3.4
Reduction	50%	77%	24%
C*	0.3/ -	1.1/ -	0.8/ -
Total	2.3/1.0	7.8/1.5	5.3/3.4
(including C)			
Reduction	56%	81%	36%
(including C)			

*Laundry C went out of business in mid 1985

commercial businesses that were potential toxicant sources, but the results showed that relatively few discharged heavy metals and only a few could be considered major sources. Site visits increase awareness for proper disposal methods and in many cases can eliminate input of accidental spills.

Accumulated sediment in the Lake Union Tunnel is a potential source of toxicants to the environment, and plans are being made to clean the line. Metro is implementing a secondary treatment and CSO control plan that will substantially reduce the volumes discharged at all CSO sites. They will begin with toxicant reduction projects that can both reduce the loading of metals and organic chemicals that enter Elliott Bay from Denny Way CSO plus speed up recovery of the offshore environment. Toxicant inputs can be reduced by continued regulation of input sources and removal of contaminated sediments from sewer lines. One possible option for improving environmental conditions is to cover the contaminated sediments with a layer of clean sediment as a cap.

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Guest Column

Puget Sound Plan Moves Ahead

By: **Katherine Fletcher**
Chair, Puget Sound Water Quality Authority

When the Puget Sound Water Quality Authority adopted its 1987 Puget Sound management plan last December, it marked the end of the first phase of the Authority's planning task.

Since December, the Authority has been involved in the second phase: working with Puget Sound residents, state, federal and local governments, businesses, farmers and others to carry out the plan.

The last several months have been eventful. While there have been some setbacks, there has also been much progress. The failure of the legislature to provide sufficient funds to carry out the plan forced the Authority to make decisions that delayed parts of the plan and transferred some responsibilities from the Department of Ecology to other agencies. These changes have been made, and the agencies are moving ahead with their tasks.

At the same time, we have made much headway with the plan's programs. In particular, the nonpoint source pollution program has moved ahead. The Department of Ecology has selected six "early action" watersheds to begin work right away on their nonpoint problems, and will also provide early action funding to ongoing shellfish protection projects in six other watersheds. The Authority has issued draft guidelines for local nonpoint planning, and the draft has undergone extensive public review. The proposed rule for the guidelines will be published this fall, and the final guidelines in January 1988.

The Authority has been working to coordinate the plan with other efforts to protect Puget Sound. A high priority is the effort of the Authority, the Department of Ecology and the Environmental Protection Agency to make sure that the National Estuary Program - and the federal funding that comes from it - is structured to maximize and support the progress we are all making with the plan now in place.

The Authority has established committees to develop 1) a comprehensive monitoring program for Puget Sound; 2) a long-range strategy for education and public involvement; and 3) priorities for research related to Puget Sound. These committees are making rapid progress in their assigned tasks. Other joint agency committees are working on boaters education, wetlands research, shellfish protection, environmental education, urban bay action plans and other tasks related to Puget Sound and the plan.

All is not easy, of course. Adequate funding continues to be an issue. The Authority will continue to press for passage of the discharge permit fee bill that failed in the last legislature. Implementation schedules must be short enough to make real progress but also allow time to set up systems and structures.

Rainy Day Blues

How rain water moves over and through the ground is important to those of us who have experienced flooded basements, wet yards, or broken septic systems. Solving the problems associated with surface water runoff and poorly drained soil is also important for improving the health of Puget Sound. Rain from roofs and driveways runs off, often eroding yards and destroying plants. This runoff may contain pesticides, oil, antifreeze, and other substances toxic to life in the Sound. You can reduce surface runoff inexpensively if you:

- Install gravel trenches along driveways or patios to collect water and allow it to filter into the soil.

Coordination of activities is itself time-consuming but is necessary to reduce duplication and inefficiencies.



Photo by Eric Meyerson

The plan adopted by the Authority is a long-term plan, and nine months is a short stretch on the road to implementation. We are encouraged by the continuing commitment of Puget Sound residents to water quality protection and the enthusiasm of the agencies working to carry out the plan. It bodes well for the future of Puget Sound.

- Resod bare patches in your lawn as soon as possible to avoid erosion
- Grade all areas away from your house at a slope of one percent or more
- Use a grass swale (a low area in the lawn) to move water from one area to another
- Plant shrubs and trees to promote infiltration

(Excerpted from **Baybook**, published by the Citizens Program for the Chesapeake Bay)

Second Annual Adopt-A-Stream Conference

A new look at what's happening to Northwest streams and the salmon that depend on them will be the focus of "**Salmon, Education and Watershed Enhancement**", the 1987 Adopt-A-Stream conference to be held October 23-24 at the Everett Pacific Hotel.

The keynote speaker will be Ralph Monroe, Washington Secretary of State. Guest speaker at the 7:00 p.m. banquet October 23 is noted writer Bruce Brown, author of **Mountain in the Clouds: A Search for Wild Salmon**. A general session on Friday entitled, "**The Environment: Yesterday, Today and Tomorrow**" includes speakers Billy Frank of the Pacific Northwest Indian Commission, and Joe Blum, Jack Wayland and Andrea Riniker of the Washington Departments of Fisheries, Wildlife and Ecology. Three concurrent sessions later that afternoon look at topics ranging from salmon biology and genetics to working with state, federal and local agencies involved with salmon and streams. Saturday sessions cover stream health, community and media involvement and the nuts

and bolts of enhancement.

A special highlight of the conference will be the "Listening Posts" activities which provide individuals the opportunity to talk one-on-one with more than 30 experts on how to raise salmon, test water quality, develop environmental education activities and more. Field trips to fish hatcheries, stream restoration projects and environmental education facilities will also be offered. Throughout the conference, displays from schools, science centers and other groups will be available for viewing. Teachers may earn credit in connection with the conference through Western Washington University. For further information contact:

Adopt-A-Stream Foundation
Box 5558
Everett, Washington 98201
259-9488
Attn: Tom Murdoch

Washington Sea Grant
3716 Brooklyn Ave N.E.
Seattle, Washington 98105
543-6600
Attn: Carol Ovens

Washington State Department of Ecology
PV-11
Olympia, Washington 98504-8711

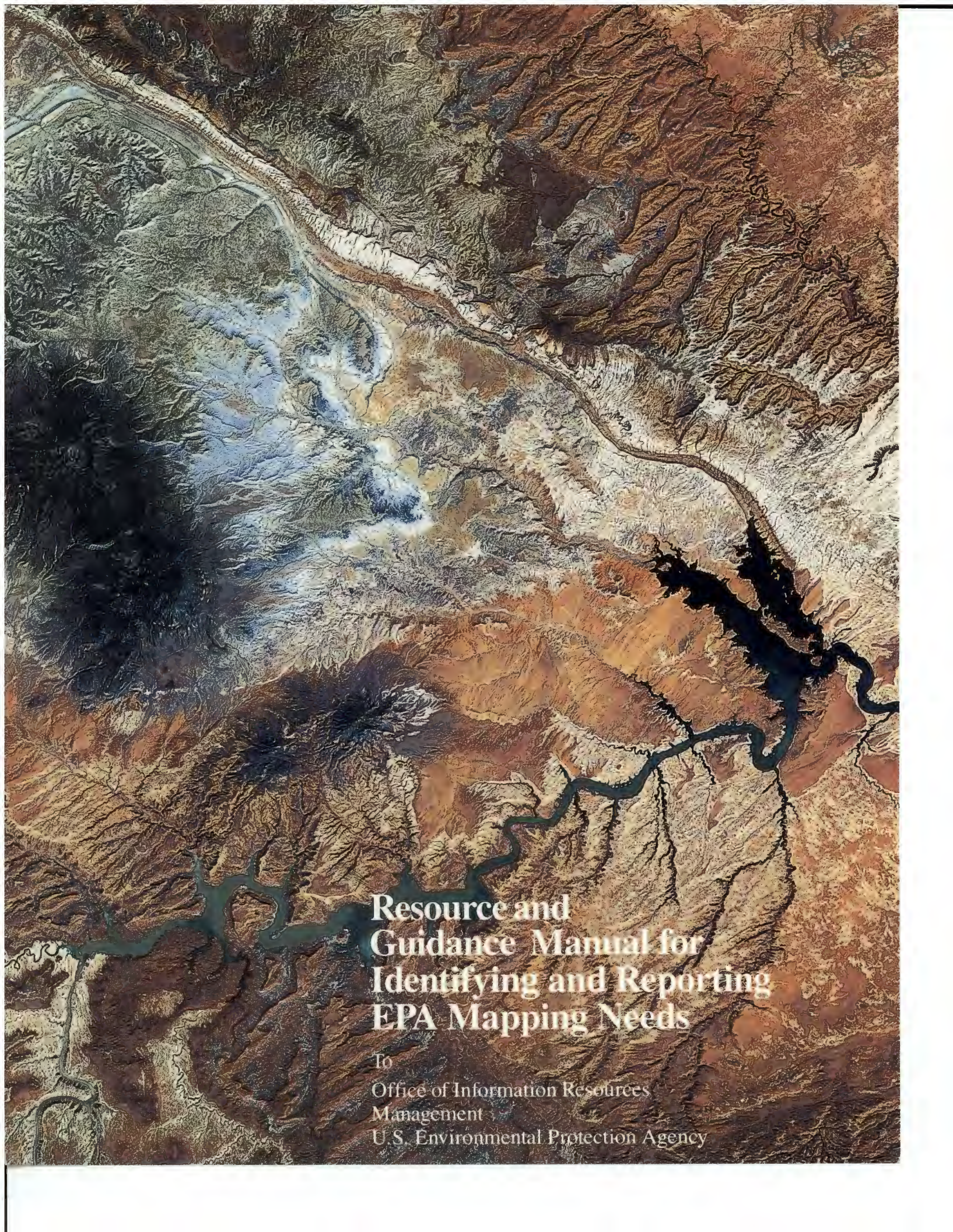
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Jointly produced by the Puget Sound Estuary Program and the Washington State Department of Ecology.





Resource and Guidance Manual for Identifying and Reporting EPA Mapping Needs

To
Office of Information Resources
Management
U.S. Environmental Protection Agency

Page
EP

NATIONAL MAPPING REQUIREMENTS PROGRAM

Description: EPA's Office of Information Resources Management (OIRM) has initiated a National Mapping Requirements Program (NMRP) to provide EPA personnel the mechanism to *identify, communicate, and acquire* the geographic information necessary to meet program office goals.

OIRM established the NMRP in response to the U.S. Geological Survey's (USGS) request for EPA participation in its national mapping programs. The focus of the NMRP was on the USGS map products and services as they pertain to EPA needs, as well as EPA's own internal mapping capabilities provided by the Office of Research and Development. OIRM, through the NMRP, is responsible for coordinating EPA's mapping requirements and its response to the USGS and other Federal agencies which provide mapping services.

Purpose: The NMRP was designed to be an ongoing program to *identify* EPA's present and long-term mapping requirements, *communicate* those needs to the appropriate agency, and provide the mechanisms for *acquiring* the geographic information. This goal was accomplished by establishing the following:

- *Mapping Requirements User's Group (MRUG)*—comprised of representatives from the Program Offices, Regions, and Laboratories, to communicate the goals and requirements of the Program.
- *National Seminar Series*—conducted by EPA and the USGS to inform EPA personnel of the mapping products and services available to them.
- *Resource and Guidance Manual*—produced to serve as a product-oriented reference document to assist EPA personnel in identifying and submitting their mapping requirements.
- *NMRP Video Series*—produced to highlight the National Seminar Series and to accompany the Resource and Guidance Manual for further review or Program summary.
- *National Mapping Requirements Program Response*—a consolidated, Agency-wide response was summarized, ranked, and submitted to the USGS for consideration in its national map production schedule.
- *Information Identification and Acquisition Process*—provided to assist EPA personnel in determining what geographic information is available, where it is available, and how to acquire it.

Program Manager: Jeffrey T. Booth
Office of Information Resources Management
401 M St. S.W., (PM218B)
Washington, D.C., USA 20460
(202/475-8410)



**Society of
Environmental Toxicology
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(202) 785-2778

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A RESUME AND CHECK MUST ACCOMPANY ALL APPLICATIONS.
Mail to SETAC at the above address.

Effective January 1, 1988

(Signature)

(Date)

You will be contacted after your application has been reviewed by the Membership Committee.

Membership

The classes of SETAC membership are: Member, Associate Member, Student Member, Emeritus Member, and Sustaining Member (organizations). Applicants for membership must share the stated purpose of the society, meet certain criteria, and pay annual dues as established by the Board of Directors.

The criteria for individual membership are:

Members—Must have applied experience, education in environmental sciences, toxicology or chemistry, or conducted research in areas related to the society's stated purpose:

- Doctorate plus two years experience
- Masters plus four years experience
- Bachelors plus six years experience
- Special appointment by the Board of Directors

Associate Members—Must have training in and be engaged in lines of work related to the society's purpose.

Student Members—Must be actively engaged in an academic curriculum leading toward a career in environmental sciences, toxicology, or chemistry.

Emeritus Members—Selected and so honored in recognition of their contribution to the society and to environmental toxicology and chemistry.

Benefits

All members receive the *SETAC News*, a newsletter highlighting environmental topics and SETAC activities, and reduced fees for the Annual Meeting and SETAC special publications.

Members, Associate Members, and Emeritus Members also receive monthly issues of *Environmental Toxicology and Chemistry* (ET&C), a peer-reviewed journal of the society. Students may subscribe to ET&C on an individual basis for \$30 per year in addition to annual dues.

Members may hold office, and with the Emeritus Members, constitute the voting membership of the society.

The myriad activities of SETAC are like the pieces of a puzzle. Each piece represents a different activity, but no piece can be placed until it is linked with the others. The society's objectives in the coming year are: (a) to assemble all the pieces needed to complete the puzzle; (b) to work on the puzzle (the outline of the puzzle is the outline of the puzzle); (c) to assemble the center of the puzzle; (d) to put the puzzle together in a logical, meaningful way.

EXPANDING SETAC AND C

SETAC-Europe

SETAC-Europe has its first joint activity of SETAC. This will be a meeting of the 10th Annual Meeting of SETAC. The measures must be taken to clearly define membership and to plan complementary activities as journal and newsletter meetings. Problems must be solved for the journal charges for the journal. The hindrance to the continued development of SETAC.

Global federation

An integral part of the SETAC is conceiving, planning and implementing a worldwide body under the leadership of Europe and other geographical regions, Pacific Rim, South America, and the function. It is unlikely that a dialogue in which the SETAC is formed within the context of a dialogue in which the SETAC is shaped. To that end, SETAC has pointed an ad hoc International Federation that I will encourage.

Legislative interaction

A SETAC goal is to provide information to legislators and other sectors to influence the development of rational environmental policy.

TRUG
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ON TOP OF

ANWR

July–August 1990, Issue 20



ARCO Alaska, Inc.

BUSH ADMINISTRATION TO PUSH FOR ANWR

In light of the crisis in the Middle East, the Bush administration has renewed its call to allow oil exploration and development on the Coastal Plain of Alaska's Arctic National Wildlife Refuge (ANWR).

Once Congress goes back into session, the U.S. Interior Department and others will try to make a strong case for Congress to act in allowing exploration of the Coastal Plain, said **Tom DeRocco**, chief of public affairs for the Minerals Management Service, Department of the Interior.

"Now that people are having to pay higher prices at the gas pump, there's a heightened awareness of the issue," said **Steven Goldstein**, chief spokesman for the U.S. Interior Department.

According to a story by the Associated Press, Interior Secretary **Manuel Lujan** — in a meeting with White House Chief of Staff John

Sununu's deputy, Andy Card — received the go-ahead to start the drumbeat toward opening the ANWR Coastal Plain to oil activities.

Sen. **Ted Stevens** (R-AK) said he will seek Senate action on a bill approved by the Energy and Resources Committee last year to permit exploratory drilling on the 1.5-million-acre Coastal Plain.

Stevens said the only way to maintain the economic security of the United States "is to gain access to the areas of the Arctic so that we might start the process of exploration."

Stevens, Sen. **Frank Murkowski** (R-AK) and Rep. **Don Young** (R-AK) previously said they would ask a new Congress in 1991 to jump-start the ANWR Coastal Plain development bill.

But Stevens said the Iraqi invasion, along with U.S. reliance on imported energy

for more than half its needs and the declining North Slope oil production, prompted him to seek congressional approval next month to open the ANWR Coastal Plain.

Production at Alaska's Prudhoe Bay, the nation's largest oil field, is declining and is now at 1.3 million barrels a day. North Slope production is expected to fall to 600,000 barrels a day by the turn of the century.

The ANWR Coastal Plain could contain as much as 9.2 billion barrels of oil, which would make it almost as large as the Prudhoe Bay field. The U.S. Department of the Interior estimates the "mean" recovery to be 3.2 billion barrels. That would still make the ANWR Coastal Plain the third largest oil field in North America.

In the U.S., only 13 fields with over one billion barrels of recoverable oil have ever been discovered.



TRANSPORTATION NEEDS SUPPLIED MOSTLY BY OIL

The U.S. Department of Energy says that oil currently supplies about 43 percent of the nation's primary energy and 97 percent of the energy used to transport people and goods.

In 1988, U.S. energy consumption was divided among three different economic sectors about evenly, with roughly one-third accounted for by industry, another third used for transportation, and the remainder used by residential and commercial combined.

In the transportation sector, petroleum products met 97 percent of the energy needs. Transportation accounted for more than 60 percent of the nation's total consumption of oil. Another 25 percent of the oil was used by the industrial sector.

Approximately \$150 billion was spent on oil used for transportation-related activities.

Although automobiles are still the primary users of oil, the amounts consumed by both light and heavy trucks have increased since the early 1970s.

The U.S. is the world's second largest oil producer, after the Soviet Union. However, while domestic production has been falling during the past four years, the nation's consumption of oil has risen.

Because domestic production of oil falls short of meeting demand, the U.S. imports crude oil and petroleum products. The cost of U.S. oil imports in 1989 was \$49 billion, about

45 percent of the nation's \$109 billion trade deficit.

Although the U.S. is the world's largest consumer of oil, it has only 4 percent of the world's proven oil reserves. Most of the world's reserves are concentrated in the Middle East.

Assuming that the U.S. and other countries import more oil in the future, it is likely that they will turn increasingly to the Organization of Petroleum Exporting Countries (OPEC) — particularly those located in the Persian Gulf region, which have the largest amounts of surplus oil production capacity and reserves.

Some 75 percent of the oil that can be produced at today's prices is found mostly around the Persian Gulf.

API CHIEF WARNS AGAINST PANIC

The president of the American Petroleum Institute (API) told Congress that "while the Iraqi invasion of Kuwait has had a substantial impact on world oil markets, we are in a much better position to handle this than we were ten years ago and there is no reason for panic."

Charles DiBona pointed out that private stocks of crude oil are currently ample and in addition "we have an asset we did not have in the 1970s — a large government-held strategic oil reserve," which totals about 590 million barrels.

DiBona said the United States should be prepared to auction the oil held in the Strategic Petroleum Reserve if necessary. The reserve, established after the oil crisis of the 1970s, could be distributed at a rate of up to 3.5 million barrels per day, according to the U.S. Energy Department.

President Bush "should give very serious consideration to releasing that oil," DiBona said. "There is no immediate pressure to do that, but that could change and we should be prepared to do that."

The White House has said it had no plans to open the reserve, which is stored in caverns in Louisiana and Texas.

DiBona warned against governmental intervention such as occurred during the Arab oil embargo of 1973 and the loss of Iranian oil production in 1979.

"In the 1970s, the U.S. government responded to market shortfalls in the worst ways possible," DiBona noted. He said the government slapped on price and allocation controls and later a special excise tax on domestic crude oil production.

The results were long

Continued on back page

PRUDHOE BAY OPERATORS TO INCREASE OIL PRODUCTION

In response to President Bush's request for increased domestic oil production, ARCO Alaska and BP Exploration (Alaska) announced recently that they are going to expedite their well stimulation program to accelerate oil production from the giant Prudhoe Bay Field.

An additional initial rate of 50,000 barrels of oil per day is expected to be produced by increasing the well fracture treatment program.

"We plan to add a total of more than 40 additional well fracture jobs to our already aggressive program," said Jim Weeks, a Senior Vice President at ARCO Alaska. "We will be ramping this program up in the next few weeks, and we plan to have the treatments completed by the end of the year," said

Dave Pritchard, Senior Vice President at BP Exploration (Alaska).

The two operators of the Prudhoe Bay Field, the largest oil field in North America, have been experiencing considerable success with these particular well treatments. Fracturing a well involves pumping a fluid at high pressures into the formation to create a parting, or fracture, in the rock, which is held open. This improves the rate at which a well is able to produce oil.

An extensive program of these treatments was already planned for 1990 — a total of some 80 to 100 treatments. Now the program has been supplemented to a level of some 130 to 140 treatments.

"And if we are able to maintain the kind of success

we have seen to date, we will be looking very hard at a similar expanded program for 1991," said Jim Weeks. Each job costs between \$250,000 and \$400,000.

This increased production is in addition to the already planned and announced GHX-1 project which will increase gas handling capacity from 3.8 to 5.2 billion cubic feet per day. GHX-1, along with the accelerated well stimulation program and other production enhancements currently being studied are expected to add 125,000 barrels per day by year end and could result in 150,000 to 200,000 barrels per day of additional production by mid-1991. This additional production will not harm the Prudhoe Bay reservoir.

NATION'S IMPORTED OIL REACHES ALL-TIME HIGH

U.S. dependence on imported oil during the first six months of the year reached an all-time high, according to the American Petroleum Institute (API).

The Bush administration's recent deferral of oil drilling along much of the nation's outer continental shelf and steadfast opposition in Congress to opening the Coastal Plain of Alaska's Arctic National Wildlife Refuge (ANWR) to oil exploration and development exacerbate an already bleak situation, said Edward Murphy, of the American Petroleum Institute.

"If we're not allowed to drill where the oil is, we're not going to reverse the (declining domestic) production

trend," Murphy said. "We'll see a shortage certainly in the next two to three years if capacity does not increase."

According to API's *Monthly Statistical Report*, oil imports accounted for almost 50 percent of the nation's oil needs during the January to June time period. The previous high for a half year was 48.8 percent during the first six months of 1977.

API also reported that total imports for June averaged over 9 million barrels per day. This was an increase of 13.6 percent over the 7.9 million barrels per day in June 1989.

Domestic crude oil production was down sharply both in June and for the first six months of the

year. In June, domestic crude production averaged only 7.065 million barrels a day, 7.3 percent less than the 7.624 million barrels a day produced in June 1989.

While imports were increasing and production was declining sharply during the first half of the year, consumption of petroleum products slipped, partly because of the first quarter's mild weather, according to API.

Consumption in the January to June time period averaged 16.868 million barrels per day compared to 17.300 million barrels a day during the same period a year ago — a 2.5 percent decline.

BUSH SIGNS OIL SPILL BILL

President Bush has signed an oil spill bill, authorizing a \$1 billion fund to cover cleanup costs and damages not paid by the spiller and setting tougher standards for ship construction.

Passage of the measure came 16 months after the *Exxon Valdez* tanker ran aground in Alaska's Prince William Sound, spilling 240,000 barrels of oil.

The bill establishes a five-cents-per-barrel tax on domestic and imported oil to create a \$1 billion fund to cover claims for oil spill response and cleanup.

The fund will pay damages to fishermen and others who lose their livelihood but cannot get compensation from the oil spiller within 60 days.

The bill requires that all new oil tankers have double hulls. It demands most existing single-hull tankers be retrofitted with double hulls or be phased out starting in 1995, with most of them out of service by 2010.

The bill allows Alaska and other states to make unlimited liability claims against the tanker operators.

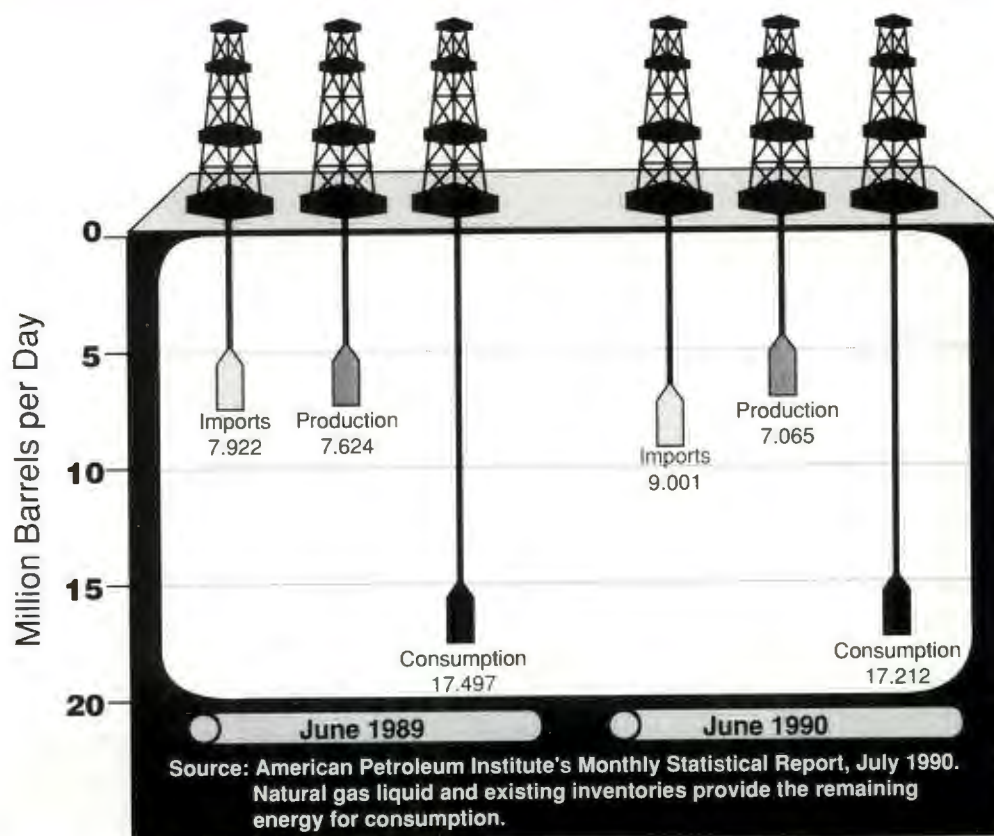
A major provision in the bill makes shippers liable after an oil spill for up to \$1,200 per gross ton of the tanker, instead of the current ceiling of \$150 per ton.

The bill calls for a special satellite, radar and closed-circuit television system to track tankers operating in Alaska's Prince William Sound, at a cost of \$6 million to \$11 million and funded by a \$50 million special account.

A new navigational light for Bligh Reef, where the *Exxon Valdez* ran aground, also was approved.

The bill calls for oil

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Joan McC

OIL BILL . . .

Continued from page 2

containment and removal equipment in the Sound that would be adequate to handle a spill of at least 200,000 barrels. It also includes a science center in Cordova, Alaska, at a cost of more than \$20 million during the next decade, to study the long-term effects of the Exxon Valdez spill on marine wildlife and the public.

The bill requires that the crews of oil tankers be tested for alcohol and drug abuse.

The bill also requires that the pilot, licensed by both the Coast Guard and the state of Alaska, guide tankers past Bligh Reef and in the waters of the Prince William Sound.

MIDDLE EAST SUPPLIES ONE-QUARTER OF U.S. OIL DEMAND

The Middle East supplied 25 percent of the crude oil and petroleum products imported into the United States from January through May 1990.

Iraq accounted for 7.3 percent of U.S. imports — second in the Middle East to Saudi Arabia's 15 percent. The third largest supplier of Middle East petroleum to the U.S. during this period was Kuwait, with 1.4 percent.

In addition to the 25 percent of these imports supplied by the Middle East, the Organization of Petroleum Exporting Countries (OPEC) nations outside the Middle East, including Venezuela and Nigeria provided 29.6 percent of U.S. imports. Canada, Mexico and other non-OPEC nations outside the Middle East supplied the remainder.

Oil Imports of Other Industrialized Countries

Other industrialized nations also rely on oil

imported from Iraq and Kuwait. In 1989, Japan imported 4.4 percent of its oil from Iraq and 6.8 percent from Kuwait. Western Europe received 8.9 percent from Iraq and 4.7 percent from Kuwait. Saudi Arabia supplied 15.8 percent of Japan's oil and 11 percent of Western Europe's.

The Middle East accounted for an estimated 27 percent of world crude oil production in 1989. The largest producing nation in the Middle East was Saudi Arabia, with 8.3 percent of world oil production, followed by Iran with 4.9 percent, Iraq with 4.8 percent and Kuwait with 2.6 percent.

U.S. Oil Imports Reach 50 Percent

For the first six months of 1990, U.S. petroleum imports, as a percentage of domestic deliveries, reached 50 percent, the highest six-month level in history.

OIL PANIC . . .

Continued from page 3

gasoline lines created by the need to find some alternative way to ration supplies, reduced domestic production, increased domestic demand, and growing oil imports. This reaction, according to DiBona, should be avoided by the federal government and by state governments at all costs.

Listing some of the long-term options that are available, DiBona mentioned increased oil exploration and leasing in U.S. offshore waters, and opening the Coastal Plain of Alaska's Arctic National Wildlife Refuge (ANWR), which is believed to hold billions of barrels of oil.

DiBona testified in early August before the U.S. House Energy and Power Subcommittee and the Consumer Subcommittee of the Senate Commerce Committee.



UPDATE

VOLUME 1 • ISSUE 5 • SEPTEMBER 18, 1990

PRINCE WILLIAM SOUND FISHING SEASON BREAKS ALL RECORDS

The 1990 pink salmon fishing season in Prince William Sound has broken all records. More than 43 million pinks, the mainstay of the Sound's fishing industry, were caught this year. According to Alaska Department of Fish and Game Officials, the 1990 catch is more than 40 percent higher than the old record of 29.2 million.

The fish harvested this summer were the juvenile fish that last year left their Prince William Sound spawning streams and hatcheries while the Valdez oil spill was at its height.

The sac roe herring harvest, the largest of the Sound's herring fisheries, was 38 percent higher than forecast. The catch totaled more than 8,800 tons. The purse seine herring

fleet posted the highest catch rate ever recorded in Prince William Sound when they caught 8,300 tons in only 20 minutes this April.

"We congratulate the men and women of the fishing industry in Prince William Sound on their efforts and these records," said Otto Harrison, operations manager for Exxon's

Alaska Operations. "We are encouraged by this fine harvest as the cleanup nears the end of its second year."

There have been no reports of finfish kills, no tainting of edible finfish tissues and no known effects of the oil spill on the fishing catch. In most cases, hydrocarbons measured in the waters of the Sound have

been at least one-thousand-fold lower than concentrations that would be harmful to fish. "Exxon's scientists will continue to monitor progress in the Sound," pledged Harrison. "Our expectations are that the results will continue to be good. "The impact on fishing has been negligible, with catches even better than expected."



Alaska fishermen hauled in a record catch of pink salmon from the waters of Prince William Sound during the 1990 fishing season.

STEP INTO THE SOUND

To experience Gary Kremen's "Tribute to Prince William Sound," you literally step into the painting and are transported to a land of abundant wildlife, glaciers, and tree-covered islands.

The 62-foot-long canvas envelopes you, capturing the beauty of the Sound, along with the love that Kremen obviously has for the environment.

"I fell in love with the Sound when I first saw it in 1978. The place is so majestic, so pristine. It's nature at its best. I've been around the world, and I've never seen anyplace like Prince William Sound."

The tribute is part of Kremen's effort to

murres, and puffins flock. Waterfalls and calving glaciers complete the scene. Music surrounds you, adding to the majesty of the experience.

If you've been to the Sound, you may feel as if you recognize the place, but it does not represent any particular site.

"I took images from my mind," Kremen says. "To be a real picture of art, it has to come from your imagination ... from the heart."

In fact, it is this spirit that makes the tribute more meaningful than a photograph. "Paintings convey a lot more than photos. There is more to a painting — feeling,

Last September, the concept for the painting came to Kremen. "I saw the whole thing in my head. It's the greatest work that I have ever done, but I could never have done it until this moment in my life."

It took Kremen until March to work out the engineering details — to locate the length of continuous canvas, to design and construct the free-form frame, and to devise a huge wooden pin that enables the painting to be rolled up for easy transportation.

A prime objective of the mural is to educate people about species that live in the Sound, and to see them in their natural environment. The back of the mural will



Artist Gary Kremen captures the beauty of Prince William Sound, "It's important that people know that the Sound is not ruined."



correct the misconception that the Sound is dead. "I got tired of seeing the same dead otters and the same loon on TV. People in the Lower 48 think all the beaches are still covered with oil and all the animals are dead. That's not true."

A frequent visitor to the Sound, his passion for the area shows as he talks, "People need to know, whether they ever visit the Sound or not, that it is still here. That they can see all the birds and animals. It's here to enjoy now, and it will be here for your grandchildren to enjoy."

Wander through the mural and gaze upon a kittiwake rookery, observe a grizzly bear and her cubs on the shoreline, and watch a pod of orca cruise past. A bald eagle lights on a nearby treetop, while cormorants,

impressions," Kremen says.

The unique painting is a compilation of Kremen's wide range of life experiences — his degrees in natural resources and architecture, his participation in a national art tour, his work as a commercial salmon fisherman in Alaska. He came to Alaska in 1977 on the art tour and stayed. First, working as an architect, then turning to commercial fishing. Catching salmon during the summer supported his painting through the winter. He eventually opened a studio in Anchorage.

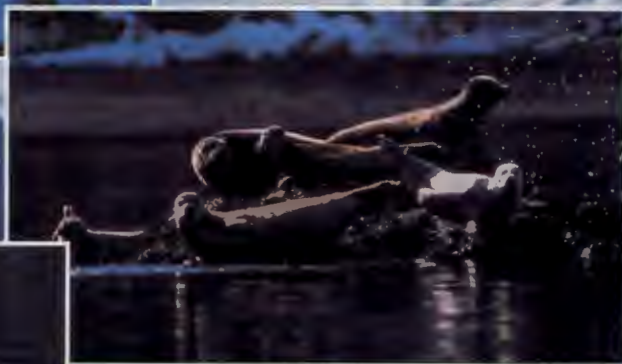
When the spill happened, Kremen was angry. "This happened in my backyard, and I care about the environment." He put down his brushes, and began designing and building booms to help with the spill.

display photographs, animal sketches, and information about the history and culture of Prince William Sound.

The tribute to the Sound was first displayed at the Egan Convention Center in Anchorage in early June and was on exhibit in Valdez in July. Kremen hopes to exhibit it throughout the Lower 48. The painting is the subject of a videotape being made for the Public Broadcasting System.

Wildlife ad appears in magazine

The advertisement on the following page appeared in Alaska Airline Magazine. It is part of Exxon's effort to support Alaskan tourism.



Prince William Sound Spring 1990

These photographs taken during the spring of 1990 along the Prince William Sound shoreline reveal an emergence of wildlife in areas impacted by the 1989 oil spill. Exxon's continuing clean-up operations in the Sound and Gulf utilize techniques that support natural environmental recovery and create minimal disturbance to the environment. Prince William Sound continues to offer visitors some of the world's most spectacular scenic and wildlife experiences.

EXXON

VIEW ON THE SOUND

"It feels good to be here helping with the cleanup."



Nick Martinez

Though he lives on an island in Maine, Nick Martinez has spent a lot of time in Prince William Sound and the Gulf of Alaska. As First Assistant Engineer with Exxon Shipping Company, he has hauled crude out of Valdez since 1979. During last summer's cleanup activities, he worked out of Seward, booming free floating oil. He continued to work during the winter and spring months, maintaining booms, and escorting scientists to the shorelines for studies and surveys. Now this summer, he is a squad leader aboard the *Adele Candies*, supervising about 10 workers picking up remnants of oiled debris and tarballs left in scattered locations along the shorelines.

"I'm personally surprised at how well the Sound has been cleaned up. Some oil is still there but no where near the extent you would be led to believe by the media," Martinez says.

"When you are working up here, you see things that very few other people get an opportunity to see. We were on the beaches the other day and saw sea lions playing in the water, mussels and barnacles on the rocks, seaweed and algae on the rocks, and hermit crabs and fish in tidal pools."

Martinez comments on the successful cleanup combination of workers and natural processes:

"Nature takes care of itself real well, but we speeded up the process of getting the shorelines back to their natural state."

"Just seeing the difference between last summer and now, it's obvious that we and nature are doing something right. The Sound is beautiful. It feels good to be here helping with the cleanup."

Safety concerns run both hot and cold in Alaska

During the 1990 summer program, cleanup workers in Alaska had to take precautions against both heat stress and cold stress hazards.

The summer sun heated up workers who for safety reasons wore two to three layers of protective clothing, depending on their tasks. Cleanup personnel wore chemical resistant suits over their clothes when removing oily debris. Additional protective equipment was worn when applying bioremediation fertilizers. To stay cool, workers were encouraged to drink plenty of fluids and to take turns handling the more strenuous tasks.

On the other hand, water temperatures in Prince William Sound never rose above 40 degrees. A person falling into the water was subject to hypothermia or dangerously rapid body cooling. For that reason, exposure suits were worn for certain tasks and survival suits were kept on berthing vessels for each person.

"Variable weather made dressing for work and dressing for the environment more difficult," explains Fred Brauer, safety coordinator. "We had a couple of heat-related incidents, but they were very minor. We reminded workers about the heat and cold stress prevention information they received during their training."

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