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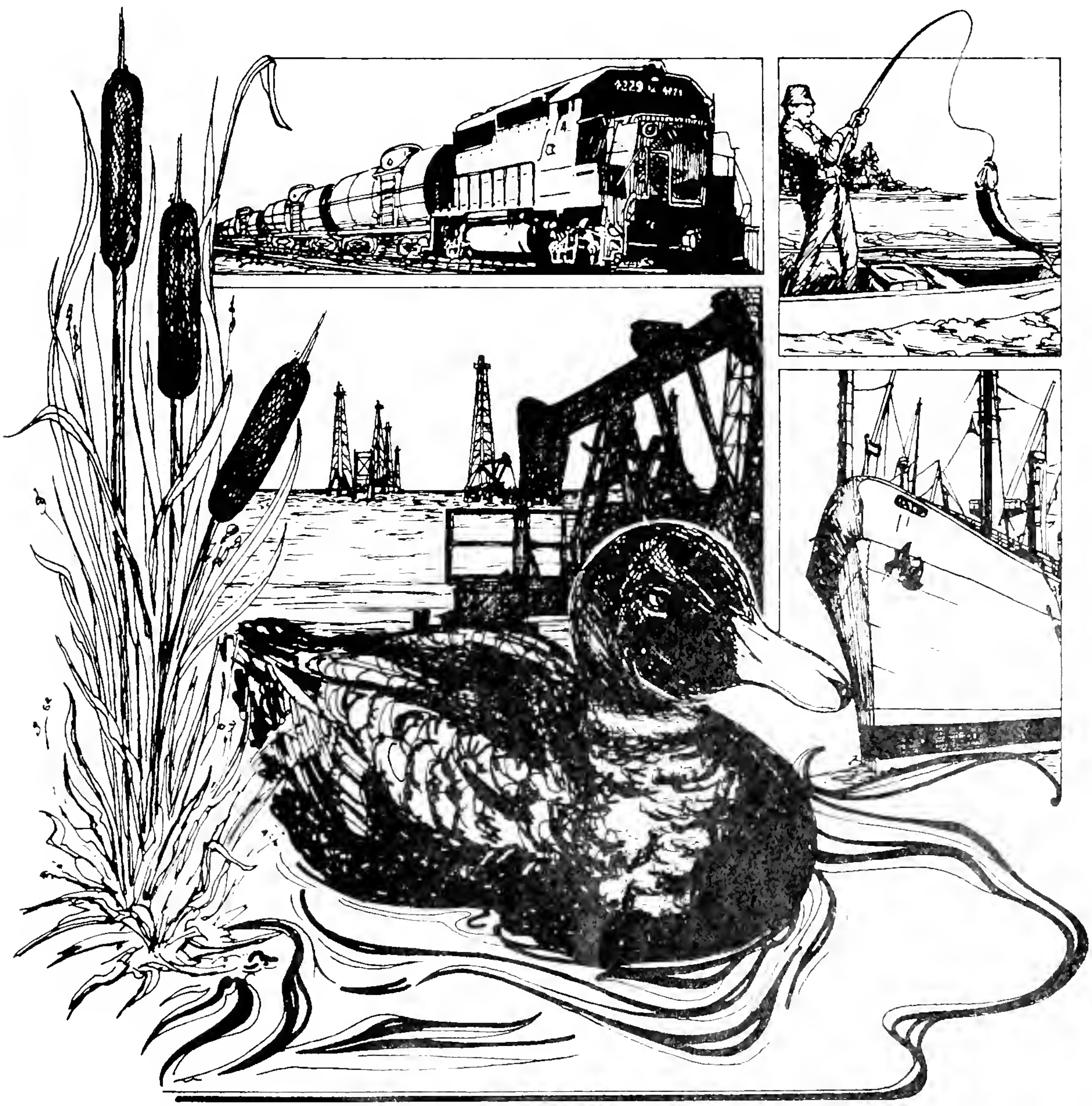
Division of Ecological Services



Proceedings of the

1979 U.S. Fish and Wildlife Service Pollution Response Workshop

8-10 May, St. Petersburg, Florida

Fish and Wildlife Service

U.S. Department of the Interior

September 1979

PROCEEDINGS OF THE 1979 U.S. FISH AND WILDLIFE SERVICE POLLUTION RESPONSE WORKSHOP

8-10 May 1979, St. Petersburg, Florida

Chairman

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PREFACE

The Fish and Wildlife Service (FWS) held its 1979 Pollution Response Workshop on 8-10 May 1979, in St. Petersburg, Florida. The workshop was designed primarily to enhance the ability of FWS personnel to provide technical expertise during oil and hazardous substances spill emergencies.

Recognizing that effective pollution response requires a team approach, the FWS also invited participation from members of the various Federal, State, and local agencies in addition to representatives of industry, private citizens, conservation and humane organizations, and the academic community.

At the workshop, 150 participants experienced an intensive 3 days of lectures, discussions, exercises, demonstrations of spill cleanup equipment, and hands-on training in the use of bird hazing devices. The final day included a simulated spill scenario, wherein participants, divided into small groups, found themselves in the character roles of Local Response Team members. Their task was to develop a response to the spill under realistic limitations of time, equipment, and expertise.

What did the workshop accomplish? In addition to providing structured training to FWS personnel, it gave participants an opportunity to exchange experiences vital to effective spill response. The status of individual contingency plans was brought into perspective. In addition, Field Response Coordinators left the workshop with more definitive plans of action they will implement to develop or to improve local plans. Two notable areas of desired improvement were increased cooperation with State and local governments and better identification of sensitive fish and wildlife habitats.

These Proceedings contain 29 papers presented at the workshop. The document is intended as a reference for FWS personnel and others who are concerned about or involved in responding to oil and other hazardous substance spills. From this exchange of ideas, it is hoped that the workshop participants and others who consult the Proceedings will be equipped to respond more efficiently and effectively to future oil and hazardous substances spills.

This workshop and these Proceedings are designed to help meet a long-term need for continuous training of all individuals involved in spill response. The Proceedings are just a stepping stone in this overall training process. Additional training will be needed as technology advances and threats to fish and wildlife resources and their habitats continue.

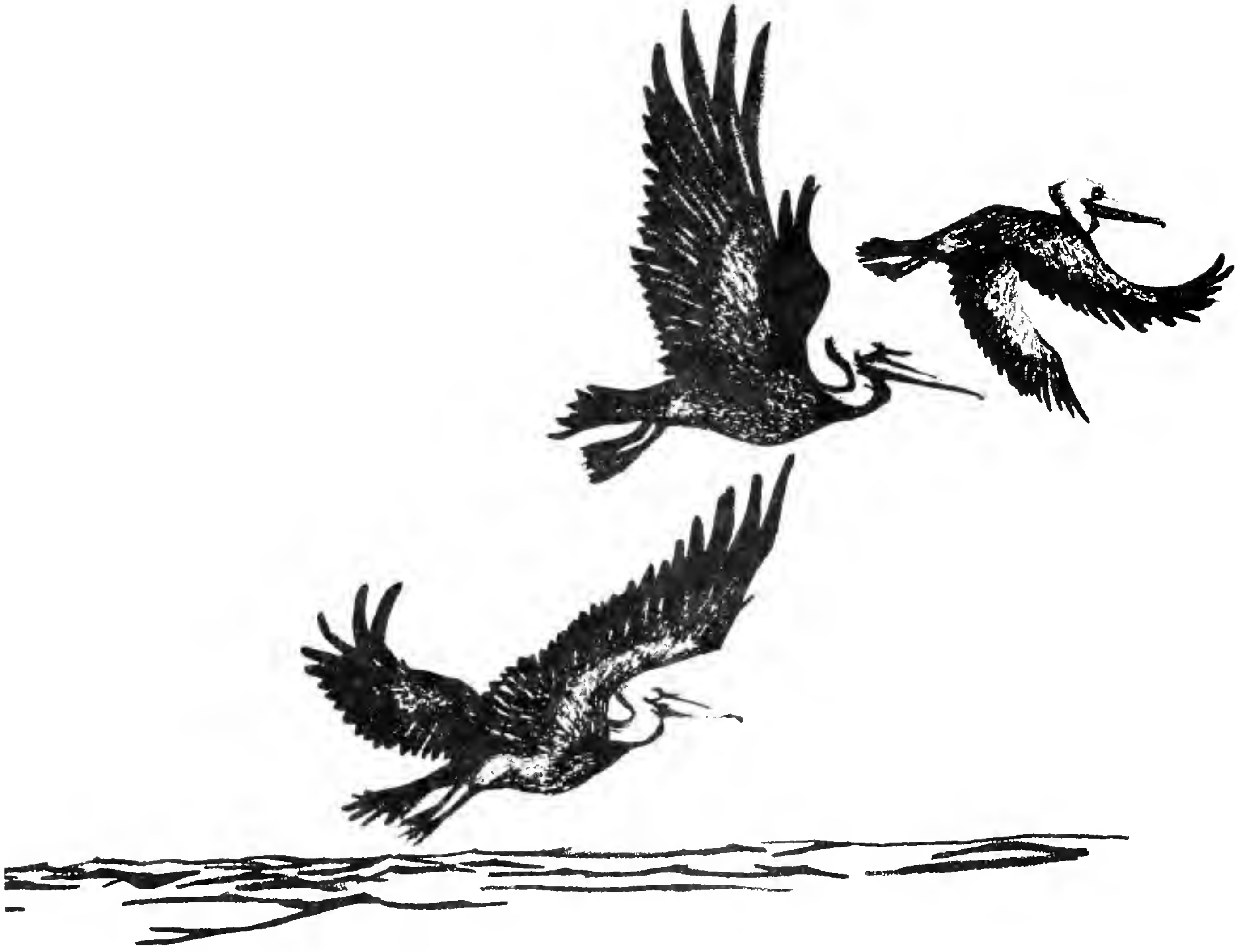
CONTENTS

ACKNOWLEDGMENTS

This workshop was designed and coordinated under Fish and Wildlife Contract Number FWS-14-16-0009-78-006. The workshop agenda and format were enhanced by the contributions of the Workshop Advisory Committee whose names are listed at the back of this document. Regional Pollution Response Coordinators ably served as moderators for the workshop sessions. These individuals are also listed at the back of this document. Special recognition is due Warren T. Olds, Jr., Chief, Division of Ecological Services, for his closing remarks at the workshop banquet. The Environmental Coastal Pollution Cleanup Services, Inc. is acknowledged for its demonstration of spill cleanup equipment. Special thanks are due the U.S. Coast Guard Marine Safety School, Yorktown, Virginia, for assistance in developing training materials for the workshop. Consumer Dynamics, Inc., contractor to the Fish and Wildlife Service, provided logistics support, assisted in facilitating the workshop sessions, and compiled these proceedings.

I

Introduction



KEYNOTE ADDRESS

Michael Spear
Associate Director, Environment
U.S. Fish and Wildlife Service
Washington, D.C.

I would like to provide an overview of Fish and Wildlife Service (FWS) programs designed to provide for and to protect our natural resources. In conformance with the environmental contaminants emphasis of the workshop, this overview will be slanted toward FWS activities to preserve sensitive and critical habitats and to protect these resources from oil and hazardous substances.

NATURAL RESOURCES PRIORITIES

It is important to recognize the breadth of the FWS involvement in this pollution response program. As a matter of fact, this conference is unique in the breadth of FWS representation. There are people here from Wildlife Refuges, Animal Damage Control, Law Enforcement, Ecological Services, Biological Services, Research, Endangered Species, and, of course, Environmental Contaminants. The oil and hazardous substances spill response effort is one of those rare programs that requires the combined contributions of many people from many different disciplines and areas to make it work. In my opinion, our system is working, and it is working well. Our effectiveness is improved by having broad involvement. We all are working toward common objectives and dealing with the same resources, yet we are applying different skills and different backgrounds to solve the problems.

The central theme of my remarks is the FWS's effort to protect high priority resources within its broad geographical area. These priorities include our specific statutory authorities at the Federal level for protecting migratory birds, endangered species, marine mammals, and anadromous fisheries as well as managing the lands in the refuge system. In the future, the quantity of Federal lands could increase by a great deal. I am referring to Alaska and the conservation of its natural resources, of course, which I will discuss later.

There are many other priorities within the FWS, but there are certain species and their habitats where our role is most critical. The FWS as a whole has been trying for several years to develop its Program Management Documents so that we can indicate more clearly where we are going in our various program efforts. For Habitat Preservation, I recently revitalized an effort to identify key fish and wildlife problems. (The resource priorities notion originally came from the FWS Region I headquarters in Portland, Oregon.) A draft of this effort, which I expect to have available in late summer 1979, will indicate what I consider to be the "top 100" resource problems in the country. This document will be particularly helpful to people involved in oil and hazardous substance spill response. There are more spills than we can handle. Therefore, we need to guide our efforts toward those areas that are most important and for which the Federal response is particularly significant.

INFLUENCE OF DEVELOPMENTS ON FISH AND WILDLIFE RESOURCES

Resource developments of all types have always threatened fish and wildlife habitats, and they always will. But as these habitats become more scarce, the remainder becomes more valuable. The loss of each additional piece of marsh, bottomland hardwoods, and potholes, whether from physical or chemical destruction, represents a greater damage to us all.

Energy development needed to maintain our standard of living will create tremendous pressures in the upcoming years. The questions are: how and where? The need for coal alone will result in strip mining on thousands of acres of land in the Great Plains, the arid Southwest, and Appalachia. The use of geothermal resources will expand. The extraction of oil from shale in Colorado and Utah may soon become a full-scale operation. The high cost of oil makes this energy source economically feasible. The new electric generating plants, transmission lines, transportation facilities, and population increases that often accompany such development projects will result in additional ecological stresses.

Oil and natural gas are primary feed stocks for the chemical industry, which is one of the largest industries in the United States, amounting to 6 percent of the Gross National Product. Chemicals are essential and have become influential in protecting human health and property. Millions of acres of agricultural crops are protected by the controlled use of pesticides and herbicides. The United States is one of the few nations that abounds with food and fiber.

Regardless of the type of development that is happening, it is almost always associated with the transportation and use of oil and hazardous substances. While some actions may cause physical damage, almost all actions result in the potential for chemical and oil spills.

As the number of marine vessels and inland barges that transport oil and hazardous substances in U.S. waters increases, so do the accidental discharges of these substances. Marine accidents, being unpredictable, can and often do occur within extremely sensitive and delicately balanced ecosystems such as estuaries. However, many inland accidents go unnoticed for days in sensitive wildlife areas because they are remote from major populations.

As an aside, in the realm of prevention, the U.S. Department of the Interior (DOI) recently took a very strong stand against the proposed refinery at Portsmouth, Virginia. While many problems were brought out, the key problem from DOI's perspective was the risk of oil spills in the Chesapeake Bay estuary. It was specifically for the protection and the minimization of that risk to shellfish that DOI took and sustained the strong action of recommending that a refinery not be built. It is significant that we would take this rather strong step in an era when energy is needed.

PUBLIC SUPPORT FOR THE ENVIRONMENT

Americans have enjoyed the extensive economic and social benefits of chemical substances. People have not, however, always realized that risks to health and environment may be associated with them. I feel that this is changing. Publicity regarding nuclear accidents, the disposal of nuclear waste (which is certainly one of the most toxic and hazardous substances), oil spills, and waste disposal has riveted public attention on such risk. The great demonstration in Washington, D.C., this spring was very closely related to the question of how we will deal with hazardous substances in the environment for generations to come. That is the most significant problem with nuclear power.

Recently, we have witnessed accidental and intentional releases of hazardous substances into the environment during transportation, storage, and other routine handling procedures. Significant environmental legislation has been passed in this decade to deal with these issues. The Clean Water Act; the Federal Insecticide, Fungicide, and Rodenticide Act; and the Toxic Substances Control Act are among the bills that directly address the control of hazardous substances.

It is remarkable that, in a time of issues such as inflation and energy shortage, the public support of environmental protection has remained high. Public support for the environment probably peaked in the early 1970's, but some recent surveys indicate that at least two-thirds of the population fully support environmental protection. And, this support is stable. Even when the public is asked whether they would pay more for such protection, the answer is yes. This fact indicates that although ups and downs can happen, the public attitude will remain favorable toward protection of the environment, especially in terms of developing and enacting additional legislation.

NEW ENVIRONMENTAL LEGISLATION

I call your attention to three significant pieces of legislation. The first is the proposed regulations for the Fish and Wildlife Coordination Act. These regulations are related to the new water policy containing planning principles and standards backed by President Carter. After months and months of effort, the proposed regulations were signed yesterday by the Secretary of

Commerce. The Secretary of the Interior signed them one week ago. These regulations concentrate on the equal consideration of fish and wildlife in water resource development projects. The regulations emphasize the use of habitat productivity as the indicator of resource value and the variable by which we measure whether appropriate mitigation is being offered. No longer can we accept a single measure of hunting and fishing as a measure of the fish and wildlife habitat value.

The second legislative item is the proposed Superfund bill, or the bill for compensation and liability for damage from spills of oil and hazardous substances and abandoned hazardous waste sites cleanup. We suggested strong emphasis on restoration of natural resource values that go beyond public health concerns to those of habitat and species. We support the principle in the Coordination Act: the restoration of habitat, not just the payment of damages. I expect that by the end of this month, the Administration will send a Superfund bill to the U.S. Congress.

The third and final legislative item concerns Alaska. This Udall/Anderson bill has been called the biggest single conservation issue of the decade and, some will say, of the century. It is up for vote tomorrow. It is very likely that we will have a bill to protect vast areas of Alaska and to open up vast areas for development. Among the areas to be protected are those valuable to caribou herds. These same areas also may contain large amounts of oil. The Administration's posture is that, for now, oil will stay there. We will extract oil from other places and try to develop alternative energy sources. If the country needs the oil from the protected land in 20, 30, or 40 years from now, Congress can reconsider its position. This posture is certainly different than the position of other Administrations in the last several decades.

RESOURCE MANAGEMENT ALTERNATIVES

The laws and policies that have been passed recently or that are still under consideration underscore the need for a better understanding of the ecological consequences of resource development alternatives. Until now, this understanding has been impeded by a lack of adequate ecological information. Although development and environmental protection frequently conflict, habitat and environmental protection considerations are now being seriously included in many decisions concerning land use. During the 6 years that I have been with the U.S. Department of the Interior, the FWS's contribution to DOI decisions has increased. The opinions of the FWS on environmental interests within DOI are sought with new eagerness. The future of fish and wildlife and their habitats depends on a continuing vigorous quest for precise ecological information. FWS is using its leadership and technical expertise to gain this information. Some of FWS's cooperative activities and programs initiated in support of our legal mandate reflect and accelerate an involvement and commitment to the management and wise use of resources in cooperation with States and other nations.

The key question is: how does the FWS cope with this complex web of statutory responsibilities over endangered species, migratory birds, marine mammals, anadromous fish, and the developmental threats to fish and wildlife? The best way to cope is to identify the key resources and the key threats and to allocate our resources accordingly.

For example, if the problem is loss of key bottomland hardwoods to agriculture, we try to apply 404 permit protection. If that fails, we consider acquisition and refuge management. We have a wider range of tools than we have ever had before for dealing with these problems. In the case of oil and hazardous substance spill response, unfortunately, we become involved when prevention has not worked. But it is one more contribution we can make towards protecting fish and wildlife.

THE FEDERAL RESPONSIBILITY

I would like to close with this thought. Too often, some of us in the FWS have difficulty giving a clear answer to the question, "why are we doing this?" It is easy to say that we protect fish and wildlife because we think that fish and wildlife are important, we think that they are part of some complex ecological web, or we believe that it is our statutory responsibility.

Our response can be summarized as follows. The benefits of protection are widespread. There are many types of habitat and many species which can only be protected by strong Federal action. The protection of anadromous fish streams far inland helps the commercial fisherman at sea. The protection of prairie potholes helps the hunter and the recreationist in Louisiana. The costs are widespread as well. The destruction of a mid-Atlantic estuary can affect the striped bass fishery off Rhode Island. The pollution upstream certainly can affect the coastal shrimp industry.

Strong Federal action to protect fish and wildlife is grounded in our Constitution and is consistent with the economic and political structure in this country. Without FWS vigorous action and advocacy, fish and wildlife resources would be in much worse shape. Therefore, as FWS personnel we expect you to protect and manage our fish and wildlife resources when impacted by oil and hazardous substance spills because you are capable and we depend on you.

PROBLEM DEFINITION

Columbus H. Brown
National Pollution Response Coordinator
U.S. Fish and Wildlife Service
Washington, D.C.

Today more than any other time in the past, our society has come to realize the problems that environmental contaminants pose. The Fish and Wildlife Service (FWS) has a great responsibility to the American people along with other Federal and State officials, industry, private organizations, and individual citizens in protecting our natural resources for ourselves and for future generations.

The destruction of fish and wildlife habitats by land and water development activities, as well as energy production, is quite evident throughout this country. The remaining habitats are subject to contamination and further damages by oil and hazardous substances.

Tanker and barge groundings and collisions which result in the spilling of oil and hazardous substances into inland canals, lakes, estuaries, and near shore and oceanic waters pose a multiplicity of problems to fish and wildlife populations and other natural resources.

Train derailments and other land-based transportation accidents involving spills of caustic acids, flammable chemicals, noxious gasses, toxic solvents, pesticides, and other hazardous substances are being reported in increasing numbers in recent years. Impacts have been witnessed in rivers, streams, estuaries, and marshes.

Pipelines, generally considered the most environmentally sound method of transporting oil and industrial chemicals, have leaked and ruptured, discharging their contents into wildlife conservation areas, estuaries, rivers, streams, open waters, and into the air.

Oiled birds have become our nation's symbol of consciousness when oil spills occur. The frequent photograph of a wrecked tanker has become symbolic of the cause of such contamination. The problem of oil spills goes beyond the bird and the tanker. It includes the broad base of natural resources and all modes of transportation that convey petroleum products.

The FWS is concerned with oil spill impacts on individual birds but, more importantly, with the subsequent impacts on their populations and to their habitats which are now sustaining longer lasting damages.

Reports of hazardous substances spills have sensitized the general public to human risk and fish kills. As managers of Federal lands we share these concerns. Hazardous substances pose significant threats to all living organisms, including wildlife populations. Their toxic, noxious, caustic, and combustible qualities pose the greatest variety of concerns towards the preservation of fish and wildlife habitats. Train derailments of hazardous substances spills are becoming commonplace. We must keep in mind that hazardous substances spills and accidents occur during their storage and while in any mode of transportation.

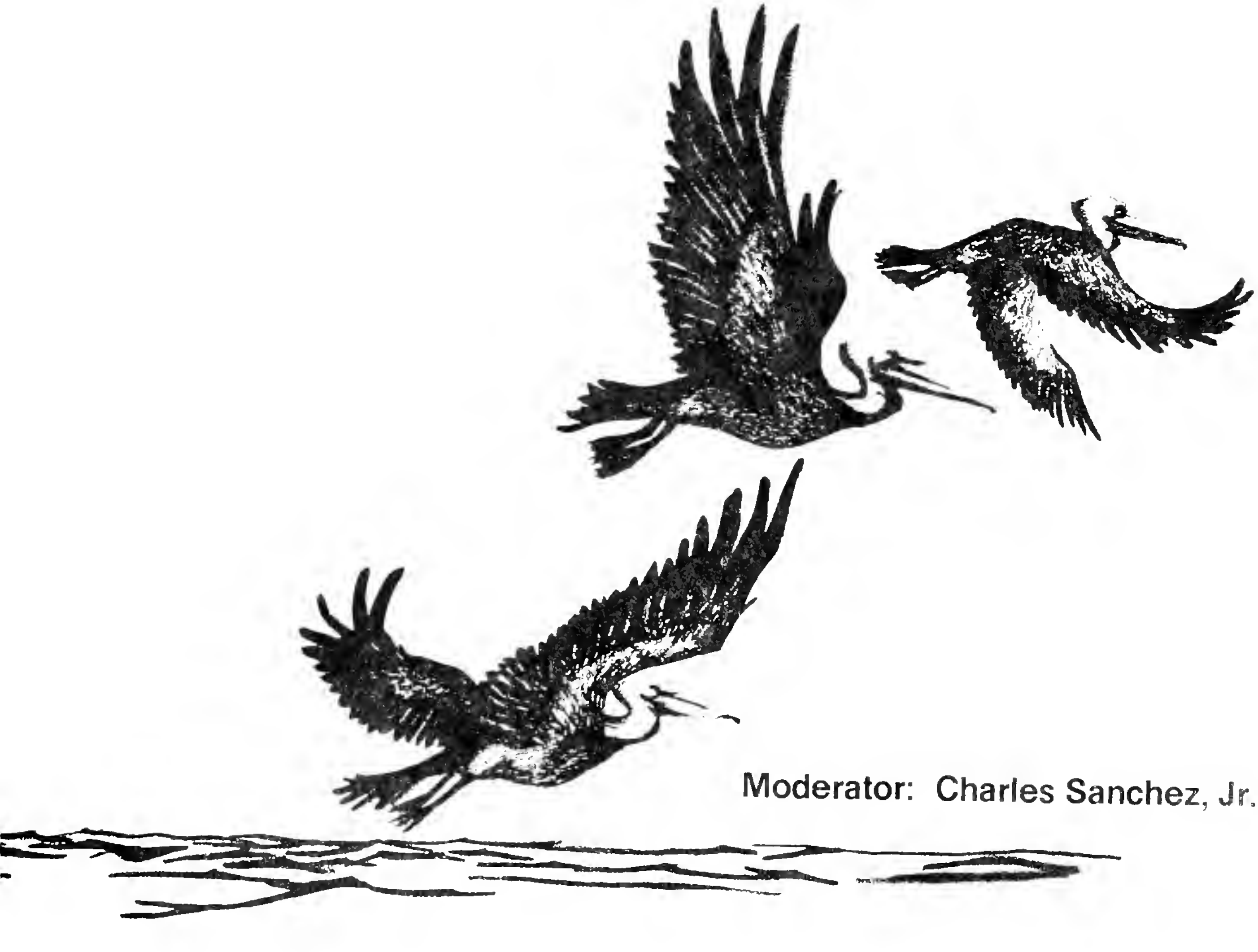
This week, we intend to take you beyond what is generally perceived by the public regarding oil and hazardous substances spills. We will focus upon the threats that these spill incidents pose to fish and wildlife resources and their habitats. With full knowledge of these problems, we shall develop a more concise understanding of what we as members of a team can do to prevent, mitigate, and restore damages to fish and wildlife resources and their habitats occasioned by oil and hazardous substance spills.

I would like to express my sincere appreciation for the esprit de corps and dedication exhibited by all of the FWS's personnel involved as pollution response coordinators. Your enthusiasm towards the protection of the resources on a 24-hour basis rather than the 8 you are paid in your job description is as commendable as it is necessary.

I would like to take this opportunity to welcome participants from other Federal and State agencies, as well as industry, conservation and humane organizations, and other interested parties.

II

Elements of Team Response



Moderator: Charles Sanchez, Jr.

THE NATIONAL CONTINGENCY PLAN: A TEAM APPROACH TO FEDERAL RESPONSE

Kenneth Biglane
Chairman, National Response Team
U.S. Environmental Protection Agency
Washington, D.C.

I had the pleasure of serving in the Federal Water Pollution Control Administration of the U.S. Department of the Interior. During that time, several colleagues and I were sent to the scene of the *Torrey Canyon* incident, where we realized the need for contingency planning. Upon our return from that incident in 1967, we were directed to form a task force with several other executive departments to develop a National Contingency Plan. I served on that task force, and an interagency plan was published in November 1968. I was also given the opportunity of writing the dispersant policy for the country. Dispersants are chemicals, as you know, that are used to dissipate oil spills. I am pleased to say that this policy is still in existence.

In 1970, Congress, pursuant to the Federal Water Pollution Control Act amendments, made the Plan part of the statutes and directed the President to write a regulation dealing with the harmful discharge of oil. I am proud to be associated with that regulation, the oil sheen regulation, because, in the 9 years that it has been in effect, it has worked. The U.S. Coast Guard deserves high marks for ensuring its enforcement. Even though there are about 10,000 oil spills in this country each year, the oil slicks and sheens that once occurred as a result of continuous effluent discharges from industry are a thing of the past (U.S. Coast Guard 1978).

The National Contingency Plan grew, of necessity, because of the increasing incidence of oil spills. The Plan never gets a chance to get dusty: it is used and strengthened every day. At the present time, the U.S. Departments of the Interior, Defense, Transportation (Coast Guard), Commerce [represented by National Oceanic and Atmospheric Administration (NOAA)], Agriculture, and the U.S. Environmental Protection Agency (EPA) participate in the Plan. Very shortly, the Occupational Safety and Health Administration also will be involved.

The National Contingency Plan functions through Regional Response Teams (RRT's) which are composed of representatives of the agencies I mentioned previously. These RRT's are environmental assessment teams that make decisions having an impact on human health and the environment. These are real-time decisions made in the presence of a panic situation, but the teams do not panic; they are deliberate and positive.

You have probably heard about the professor in Indiana who invented explosives for the U.S. Department of Defense during World War II. This year portions of his lab suddenly blew up; the RRT responded to this situation. You are also probably aware of the picric acid problem in this country. Picric acid is more potent than TNT and is found in perhaps every chemical laboratory in this country. On dessication, it forms crystals...if a bottle is jostled off the shelf, an explosion will ensue. The Department of Education and most of the school systems are calling for the removal of picric acid. RRT's have been convened because of this problem.

During the nuclear power incident in Harrisburg, there was a truck wreck in nearby Gettysburg, Pennsylvania. The truck was carrying 89 hermetically sealed drums of white phosphorus. These drums of phosphorus (which, on exposure to air, autoignites and explodes) were loaded on trailers in Gettysburg and shipped to Hagerstown, Maryland. The drums were of a 30-gallon capacity, each drum weighing 400 pounds. They were placed inside 55-gallon drums and overpacked with water to prevent exposure of the phosphorus to air. When Maryland officials heard about the presence of more than 16 tons of white phosphorus in Hagerstown, they became very nervous and ordered it removed. After all, Pennsylvania had ordered it out of <u>their</u> State.

The RRT met and entered into one of those activities that I call the "warm bubble gum syndrome." Have you ever stepped on warm bubble gum in a parking lot? When you try to wipe it off, everything you touch is besmeared. The EPA team member told the On-Scene Coordinator (OSC) that phosphoric acid was being formed in the drums, which was in turn reacting with the metal drums, creating hydrogen gas. Harrisburg had one bubble; we had 89. In addition, moving the convoy a great distance might cause the small drums inside the large drums to bang back and forth and set off a spark. The team scientists thus specified that the drums not be moved move than about 200 miles.

The U.S. Department of Defense team member found a military installation after doing a risk assessment study on all commands within a 200-mile radius. A detonation program was conducted at Ft. A. P. Hill in Virginia, and 16 tons of phosphorus were exploded, two drums at a time, eight installments a day. The incident started on 8 April, and the last drum was detonated on 19 April.

Another incident involved an Italian freighter filled with 64 tons of organic phosphates; it suffered hull fractures near the Azores, turned around, and came back to this country. The State of Virginia would not allow the freighter to come into Norfolk for repairs. Several other States also refused to accept the vessel in their ports. Virginia did not want to find out how kepone and organic phosphate pesticides mix. The U.S. Coast Guard then was faced with that warm bubble gum syndrome. The freighter was in danger of sinking and could not enter American waters, but the U.S. Coast Guard did not want to send it away, because most assuredly the seamen were in danger.

The RRT met and recommended that the EPA grant an emergency ocean dumping permit for the contaminated water in the number 3 hold and then bring in the vessel. This was finally accomplished, and the vessel was patched and sent on its way. The material was safely dumped in the ocean; NOAA did studies at the 106-mile dump site and stated that the way in which the material was disposed of presented no detectable harm to the environment.

The Associate Director for Environment, Fish and Wildlife Service (FWS), talked about future legislation, which he called the Superfund. I call it the megafund -- $6 billion. It will encompass spills of both oil and hazardous substances, as well as "orphan drums" at hazardous waste sites. Every ounce of coordination that is possible will be needed. The kinds of decisions that will be necessary in the future are going to be costly and have a tremendous impact, and the FWS can provide the talent essential to help make such decisions. The thought was expressed, "Who is looking after fish and wildlife interests?" "Well, no one else is going to do it." And when the heat is on, you are going to do the job because you are capable and we depend on you.

REFERENCE

U.S. Coast Guard. 1978. Polluting incidents in and around U.S. waters, calendar year 1977. U.S. Government Printing Office 1978-0-725-117-1324. 30 pp.

SPILL RESPONSE PRIORITIES OF AN ON-SCENE COORDINATOR

Comdr. Joseph Valenti
U.S. Coast Guard
Washington, D.C.

I am going to talk about the priorities of an On-Scene Coordinator (OSC) during a spill incident. These are priorities of all the people who have legitimate reasons for being at the scene and who have responsibilities to carry out. The OSC, provided by either the U.S. Environmental Protection Agency (EPA) or U.S. Coast Guard, simply has the responsibility to see that this process is carried out as judiciously as possible.

Certainly, if we had to list what our priorities are I think we would all agree that protection of life is foremost. Then, there are those environmental considerations that do not directly threaten a life that would be the next things that we would have to consider.

Now, an OSC by himself does not have all the knowledge to make these decisions. When we come on the scene of an accident certainly most of us would look around and see what is a life threatening situation and try to alleviate that. Most of us would agree as to what needs to be done except when we get into the technical areas where we would need specific subject experts as well.

So, recognizing that an OSC does not have all the expertise that is needed to deal with any of these situations, we have a mechanism set up through the National Contingency Plan (40 CFR 1510) to help him. The Plan is designed to get access for the OSC to people who have the information needed to make good decisions. At the top of this is the National Response Team (NRT) which is located in Washington, D.C. The Team has representatives from 12 or 13 agencies, including the 6 primary agencies. In each of the 10 Federal regions, we have a Regional Response Team (RRT). And, these teams have representation not only from the NRT member agencies within each region, but also have representation from the State. Major municipalities around ports, rivers, and harbors also should be represented on these teams. And last, but foremost, the people who are in the frontline are on the Local Response Team (LRT) which is headed by one of the Federal OSC's. Each of these people should have available a group of individuals from various agencies to assist him in carrying out the tasks.

In the past this was not the case. We had regional contingency plans and there was a RRT, and an OSC pretty much had a LRT consisting of his working staff. Then the U.S. Coast Guard was a little bit more fortunate than the EPA because the people who are the OSC's typically are the Captains of the Port and they have a decent size staff in most cases. So, they had a reasonable number of resources from which to draw. EPA was not as fortunate because it does not have as large a staff. Even though it did not burden the U.S. Coast Guard as much from the standpoint of staffing, we in no way had the expertise that was needed to deal with specific problems. In recognition of this, we ended up contacting the RRT everytime we needed someone from another agency.

We started to develop contacts at the local level so we would have people to put the right finger in the dike on scene. These contacts continued to grow, making it unnecessary for an OSC to call the RRT every time he needed assistance. Now the LRT is operational. It also will indicate that in addition to regional contingency plans we will now require local contingency plans. Now, this is not really a brand new change. This has been required for a while. As a typical bureaucracy however, we are finally getting the change into the national plan. However, it is one of the evolutionary things that we have found is necessary for us to have an effective organization. We have to do as much of the planning ahead of time as we possible can in order to be successful. A regional plan with a regional group of people simply does not have the detail needed to work on the local problems that we are confronted with in responding to a pollution incident.

The new change to the National Contingency Plan will call for OSC's to develop local contingency plans that identify: 1) the most probable types of accidents that are likely to occur within an area, 2) what the products are, 3) where the accidents are likely to occur, 4) how much of the product is likely to be involved, 5) which of the various environmentally and esthetically sensitive areas are potentially going to be impacted by these incidents, and 6) what can be done to protect these particular areas if the most probable incidents occur. Once an OSC has all of this information, he will be able to identify and locate all the needed talents to try to deal with these situations.

This translates to the need for what I previously called a multi-agency response. In recognition of this, the National Contingency Plan will call for the members of the RRT's to designate people to work with the OSC in developing the local contingency plans and in responding to these particular incidents.

There are two typical types of pollution response cases on which you as an individual will be called upon to serve. One situation is where the discharger has assumed the responsibility for the cleanup. The other case is where either we do not know who is the discharger, or he has declined responsibility, or is not acting in a responsible manner.

In the first case, the task of the Federal Government is to give advice to the person who is trying to clean up and guide him in doing what is considered appropriate. This includes advice on such things as protecting the wildlife. It is not enough to simply do a good job in removing the oil, or in mitigating the hazardous substance. There needs to be concern for the environment as has been indicated.

What we have to do is advise the individual as to where he can locate the expertise he needs, and where he can obtain necessary supplies. Maybe he can use some of the same people. For example, if FWS has arrangements for volunteers, maybe some of these people can help. We have to make the spiller aware that volunteers exist, how to obtain them, what they are going to need when they get there, and help obtain these supplies.

When the spiller is not known, or not acting responsibly, the Federal Government should take over and accomplish what needs to be done. In this case what kind of information does the OSC need? Essentially, what he would like to do is to say: "FWS representative, you are my expert in this area, please tell me everything that needs to be done." "You evaluate the situation, explain what actions are needed, plan whatever actions are necessary and tell me basically how much it is going to cost." And, that is how the operation should be operated. The OSC wants to take that particular aspect of the situation and have the individual who has the expertise in that area work on it. This individual then develops an action plan and indicates how much funding is needed to carry it out.

Essentially, dealing with pollution incidents can be done either way. If you, the FWS representative, are called upon and get there and think it is not being done correctly, it is imperative that you explain this to the OSC and make him understand that something else has to be done. Do not hesitate if you are in this particular position to recommend that the Federal Government take over the particular aspect of the cleanup if it is necessary. If you do not think it is being done correctly, let the OSC know. He does not necessarily know that something is wrong. Remember, he does not have the expertise in your particular area. You will find very few people in the U.S. Coast Guard who have any knowlege of the particular expertise that you have and you must consider that when you are dealing with them.

In this particular area, there are very few of us who have any talent whatsoever. And, we look to you for full participation and partnership in this particular area. One of the important parts of this, of course, is the contingency planning. We do have spills quite frequently. Large spills however occur infrequently. Therefore, you have to have coordinated exercises from time to time. Part of any exercise should involve volunteer groups that you are planning on calling to assist in these situations. For example, when an OSC or RRT is planning a drill, I would recommend you bring this up. Point out that this should be a valid part of the exercise as it is part of what happens. Again, we are looking toward you as a group to tell us what to do in this particular area.

From time to time you will be asked to act as a spokesperson when you are at the scene of a spill. The OSC must insure that the correct spokespersons are placed before the public for each and every part of the effort. We do not have the expertise to talk in this particular area. Nor do we have the expertise to talk in a number of other areas. For example, in a technical cleanup involving chemicals, we would want a chemical expert to be there. The same is true with a bird cleaning operation, if this is what we are doing, because the public will want to know what we are doing to protect the fish and wildlife in the area.

No matter how much good planning is done or how good a LRT is, there will be occasions when they are in a situation they cannot handle. And, we have a mechanism to help them in this particular case. This is the RRT. I will not elaborate on what the RRT is going to do. I shall simply state that at this point it is the group that you are going to go to on the local team, when you need some supplies, more people, and you cannot deal with it at the local level.

There are going to be differences of opinion as to what are the priorities on the scene from time to time. Everyone will have to recognize that. There are State people, local people, concerned public citizens, and yourselves, all with an interest in your particular area of expertise. We will look to you to try and to get these groups together in hopes of reaching a consensus. No matter how hard you try there are going to be occasions when agreement cannot be reached. When disagreement occurs on the local team, do not hesitate to bring it to your representative on the RRT once you have made an honest effort to solve the problem at the local level by bringing the problem to the OSC's attention. But, you really must make an effort to let the OSC know how you feel. If you cannot resolve it at the local level, take it to the RRT.

The worst thing that anyone of us can do in this particular effort is to sit there and be disturbed about something rather than try to resolve the problem. This is important for all of us. We have to get to the point that we can work with one another and tell each other what is on our minds, express our concerns, our opinions, and carry out what we consider to be our responsibilities and feel that we have the right to do that. This is extremely important. I encourage all of you to take a very active role in all aspects of the LRT and the RRT.

I assure you that the National Pollution Response Coordinator takes an active role on the national level. He expresses his concerns and he carries out his responsibilities. This is the only way that we are going to improve what we have now by admitting where we have problems, bringing them to the attention of the appropriate individuals on the team, and trying to solve these problems collectively.

We have an outstanding mechanism for dealing with pollution emergencies. It can only get better by the concerted efforts of all of us who are involved. I know how much you people have done in the past in support of the OSC's. For the U.S. Coast Guard and for EPA, I thank you very much. We look forward to working with you in the future.

THE DYNAMICS OF REGIONAL RESPONSE TEAM DECISIONMAKING

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The natural evolution in public concern about the environmental and public damage potential of oil and hazardous substance spills correlates well with the development of the chemical and fossil fuel industries. There are, perhaps, 30,000 different chemical compounds "free wheeling" in the various market systems in this country today, and the list is growing. The use of petro chemicals has experienced tremendous growth and the fossil fuel problem is known to even the disinterested. The demand for these products in the consumer market is the genesis of our problem. The compounding factors are of course the effects that these products may have on the environment, and/or public health, and welfare. Couple these concepts with dozens (perhaps more) of local, State, and Federal statutes, rules, regulations, and ordinances articulating various and, at times, overlapping interests and you can begin to imagine the scope of the problem generated when a spill type emergency happens. How this problem is effectively dealt with is what we will discuss.

How, for example, do Government agencies apply all of the laws to the problem in such a sane fashion that the public and the environment are the ultimate benefactors? How do we insure that all vested interests have been duly considered and applied to the situation? How do we economically apply the latest and most appropriate technical concepts? Finally, how can we rationally deal with competing value judgments? The answer is emergency management via the contingency plan process offered by the National and Regional Contingency Plans.

The four principles mentioned previously distinguish the Regional Response Team (RRT) from the National Response Team (NRT) which is more devoted to policy and national resolution.

In the writer's opinion, no concept in Government management has proven more successful than the legally based, nationally guided, and publicly stimulated "team" concept of emergency management. The dynamics of decisionmaking under emergency pressure is mind boggling; value judgments are such that no one agency, expertise, or individual can resolve all the issues. To sense the scope of this problem, one need only envision a typical scenario--a train derailment at Axis, Alabama. This accident, just at the U.S. Environmental Protection Agency (EPA)-U.S. Coast Guard spill jurisdiction boundary, has killed two of the train crew and four nearby residents. Various chemicals and oils were being transported. In these ruptured and leaking cars were vinyl chloride, metalic sodium, No. 2 fuel oil, No. 5 heating oil, sulphuric acid, chlorine, carbon disulphide, and amino toluene. All, or parts, of these various otherwise useful and expensive products are flowing directly into the Mobile Riber. The weather on this November day is cool, foggy, and threatening rain. There are several private wells in the area and two domestic water supplies taking from the Mobile River just downstream from the accident site. Also, there are five large industrial water intakes (including a power plant) in the same vicinity. The time of the event is 2:00 a.m., Sunday. What laws (Federal or other) will embrace the largest portion of this event, what funding is immediately available, what or who has legally vested interests, and, finally, who may have significant moral interests? At the risk of leaving something or someone out, let's examine the interacting dynamics of this madness.

It is clear that the spill of the various materials is critical. Thus the Federal Government will view all matters relating to the event as a Section 311 (P.L. 92-500) exercise. The RRT will be the principal operational element; but who will have input to the decisionmaking processes? Would you believe that the listing is as follows?

1. U.S. Environmental Protection Agency (EPA):

   a) Solid Waste Program, Resource and Conservation Recovery Act (RCRA)
   b) Environmental Emergency Program (Section 311)
   c) Drinking Water Supply Program
   d) Toxic Material Program, Toxic Substances Control Act (TSCA)
   e) Public Affairs
   f) Surveillance and Analysis Program
   g) Legal.

2. U.S. Department of Transportation - U.S. Coast Guard:

   a) Marine Environmental Protection
   b) The Gulf Strike Team
   c) The Public Information Assistance Team
   d) Marine Safety Office (MSO).

3. U.S. Department of Defense:

   Note: Could be any one or more of several agencies; i.e., U.S. Army Corps of Engineers, Navy, Army, Explosive Ordinance Disposal (EOD Team).

4. U.S. Department of Commerce - National Oceanic and Atmospheric Administration:

    a) Weather Bureau
    b) Scientific Support Group.

5. U.S. Department of the Interior:

    a) Fish and Wildlife Service
    b) Heritage Conservation and Recreation Service
    c) U.S. Geological Survey
    d) National Park Service.

6. U.S. Department of Agriculture (Forest Service).

7. U.S. Department of Health, Education, and Welfare, Communicable Disease Center (CDC).

8. U.S. Department of Justice (U.S. Attorney).

9. Federal Railroad Administration.

10. National Transportation Safety Board (possibly, FBI).

11. Bureau of Explosives.

12. Defense Civil Preparedness Agency (subject to reorganization). Federal Disaster and Assistance Administration (if power threatened).

13. State Agencies:

    a) Water Improvement Commission (Air and Water)
    b) Health Department (Solid Waste and Water Supplies)
    c) Civil Defense
    d) State Patrol
    e) National Guard
    f) Governor may appoint a special representative.

14. Local:

    a) The Mayor, et al.
    b) The County Judge (in certain States)
    c) Civil Defense
    d) Police
    e) Sheriff
    f) Press (local and national).

15. Political:

    Varies <u>but</u> always involves Congressmen, Senators, local, and national.

All of the preceding entities have a legally vested interest via some statute, regulation, or ordinance. There are certain groups or individuals who have a moral, civil, or legal invitational right to be involved. They include the following:

16. Affected Parties:

   a) The railroad company
   b) The shippers and/or product owners
   c) Industrial expertise groups - Chemtrec, etc.
   d) Property owners
   e) The injured
   f) Audubon,
      Save the River,
      Other Environmental Groups.

The RRT may never consist of all these entities. In fact, a normal RRT consists usually of 10 to 15 people. It is emphasized that each interest mentioned previously (and perhaps others) will have a public, if not legal, right to assert a view or position in the "typical" scenario. This, then, is the generator of the dynamics of the decision process. Finally, what is the forum for these views and who is in charge?

Prior to 1968, it was "every jurisdiction and authority for itself"; the resolution of issues was unilateral and individual participation was ad hoc. In 1968, using the Federal Water Pollution Control Act as a basis, the Regional Response Team (RRT) concept was formalized. This Federal team augmented with State, local, and other members has served the southeastern States well. As to who is in charge, no one really is, simply because there is no effort to perfect a single solution. There is a Federal On-Scene Coordinator (OSC) who is the single Federal official designated by law to "coordinate and direct Federal pollution control efforts." This authority extends to "public health and welfare."

It is true that there is no perfect solution, but there are singular resolutions of problems that must be made involving serious competing interests. The OSC must, using some rational procedure, determine and implement the final resolution of each issue. In the domain of EPA, Region IV's RRT area (inland) the system of discussion, conflict, and voting among those with the appropriate expertise is often used. Economics is pitted against wildlife, time against money, ducks against shrimp, forestry against water supply, "endangered species" against human life and/or environment, and so on. The idea in this system is that considering all factors and alternatives, if ducks must lose then that decision has been made by the best in that field of expertise at all interest levels.

Finally, please always remember that we are talking about emergencies, not long range, practical applications. Time is all important, data are usually crude, and experience is paramount.

SUMMARY OF FLORIDA'S OIL SPILL ACT AND DEPARTMENT OF NATURAL RESOURCES RESPONSIBILITY

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Pollutant spills are a fact of life in technological societies. To mitigate the resulting damage and destruction, legislation delegating authority and specifying procedures to be followed in managing such spills is necessary. Such legislation was enacted in Florida in 1970. It is called the "Oil Spill Act" (Chapter 376, Florida Statutes).

On 19 March 1971, however, the U.S. District Court of Florida issued a temporary restraining order enjoining the enforcement of Chapter 376. The restraining order was officially lifted on 11 July 1973. In 1974, the State legislature enacted Chapter 74-336, which amended Chapter 376. Rules and regulations were adopted after public hearings in August 1974.

PROVISIONS OF THE OIL SPILL ACT

The Oil Spill Act empowers the Department of Natural Resources to deal with the threats of danger and damage posed by pollutant spills. It defines example discharge, terminal facility, owner, transfer, and other terms; provides that any person making fraudulent statements in response to the certification requirements is guilty of a second-degree felony and levies upon each registrant an excise tax for the privilege of operating a terminal facility and handling pollutants.

The Act also defines liabilities and defenses of registrants and vessels; limits the liability of any vessel for damage resulting from nonwillful discharges to $14,000,000 or $100 per gross registered ton of such vessel, whichever is less; limits the liability of a terminal facility for damage resulting from nonwillful discharges to $8,000,000; and establishes procedures, whether by arbitration proceedings or court actions, for handling claims for damage resulting from discharge of pollutants.

In addition, Chapter 376 raises the limit of the Florida Coastal Protection Fund from $5,000,000 to $35,000,000 and specifies purposes relating to abatement and cleanup of pollution for which the money in the fund may be used. To date, the Coastal Protection Trust Fund has a balance of $24,192,167.78, which is invested in U.S. Treasury Bills and Certificates of Deposit, and a cash balance of $253,116.38. These monies were derived from the 2¢-a-barrel excise tax, revenue from license fees and penalties, interest earnings from investments, legislative budget appropriations minus expenditures for operation, reimbursement for damages, and Department contractual obligations (cleanup operations).

DEPARTMENT RESPONSIBILITIES

From April 1973 to December 1976, on the average, there was a spill in Florida every 46 hours. Since then, there has been a spill, varying from 1 quart to 30,000 gallons, every 88 hours. These spills emanate from vessels, terminals, trucks, and other sources. Among their causes are equipment failure, accidents, and negligence. Among the pollutants involved are diesel fuel, bunker C, gasoline, and lubricants.

The role of the Department of Natural Resources in cleaning up these spills is specified by the National Contingency Plan. Oil spills must be cleaned up to the State's satisfaction. A member of the Department is assigned to the Regional Response Team (RRT) and to the On-Scene Coordinator (OSC). Tar balls on the beach are cleaned up under State contract. The State Department of Environmental Regulation is responsible for designating waste sites and plays a key role in approving the use of chemicals to control spills.

The Department of Natural Resources responds to pollutant spills within each of its regions in accordance with the procedures outlined below. Florida has five designated regions.

I. Notification

Once the Department is notified of a spill or has discovered a spill, the following persons should be notified:

A. Responsible party in the event that such party is now aware of the discharge.

B. U.S. Coast Guard.

C. State Department of Environmental Regulation (on inland spills).

D. U.S. Environmental Protection Agency (EPA) (on inland spills).

II. Containment and Cleanup

Responsibilities should be initiated in the following manner:

A. Responsible party should respond or contract for the work.

B. In the event that the responsible party does not respond, it will then be the responsibility of the U.S. Coast Guard (in coastal waters) or the EPA (on inland waters).

C. Chemical dispersants are not to be used without prior approval from the OSC, the Department of Environmental Regulation, and the EPA. Authorization will be on a case-by-case basis.

D. The State will contract for removal of pollutants or cleanup operations if the responsible party does not respond, if the U.S. Coast Guard does not respond, or if the cleanup operations are not satisfactory. If or when it becomes the responsibility of the Department to contract for cleanup operations, the following questions should be considered:

1. Can the local county supply the manpower and equipment?
2. Is there a Florida Spillage Co-op in the region?
3. Are there third party contractors within the region?

E. All pollutants and contaminated debris, regardless of who performs the removal, must be disposed of in an area approved by the Florida Department of Environmental Regulation.

III. Damages

Any person claiming to have suffered damages as a result of a discharge of pollutants may apply within 12 months after the cause of action occurred. Damage claim forms are to be furnished by the regional office. Whenever a discharge occurs and there is a responsible party, the claimant's legal agents or insurance agents must be identified. In the majority of spills, the responsible party is known, and damage claims can be coordinated through this party's insurer. Spills of unknown origin that cause damage should be handled in the following way:

A. The party suffering damages should request a damage claim form. Whenever a claim form is submitted, an investigation is conducted to ascertain the validity of the claim.

B. Estimates are needed for the cost of work in the area in which damages occurred, e.g., cost per foot for hauling or hourly rate for hauling.

IV. Reports

The following reports are to be completed on all spills investigated by the Department:

A. Preliminary Report.

B. Investigative Report.

C. Narrative Report.

D. Cost Report.

Reports are to be maintained for 3 years by statute.

THE U.S. DEPARTMENT OF THE INTERIOR AS A TRUSTEE OF NATURAL RESOURCES

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INTRODUCTION

The Federal Government is the largest single landholder in the United States. Over 300 parks and over 300 refuges are managed and protected by the U.S. Department of the Interior (DOI). In addition, other large Federal landholdings are managed by the U.S. Department of the Interior and the U.S. Departments of Agriculture and Defense. This means that there is a strong potential for a large number of oil spills and hazardous substance spills to occur on or affect areas for which the Federal Government is responsible. These areas include: public lands, Indian reservations, national wildlife refuges, national parks, national forests, and national seashores. Oil and hazardous substance spills can and have damaged a wide variety of esthetic and recreational values and wildlife, including migratory birds, endangered species, and Indian fish resources. The Fish and Wildlife Service (FWS) alone responded to 350 spills last year, and already has responded to more than that number so far this year.

The Federal Water Pollution Control Act (FWPCA), 33 U.S.C. §1321(f)(5), and the Outer Continental Shelf Lands Act Amendments, 43 U.S.C. §1813(b)(3), make it clear that the United States is responsible "as trustee" for the protection of the natural resources under our jurisdiction. These statutes also give DOI the authority to protect natural resources by suing spillers for damages to these resources, and provide that sums recovered shall be used to "restore, rehabilitate, or acquire the equivalent" of the damaged natural resources. I will discuss this aspect of the law in more detail in a moment. I also will discuss the use of criminal sanctions against spillers who harm federally protected species such as migratory birds or endangered species. Before turning to these subjects, I would like to briefly discuss the United States' rights and duties concerning wildlife in relation to those of the States.

The United States is presently making its very first claim for damages for harm to wildlife in the Oswego Barge case, although States have made such claims in the past. We expect to succeed in making such claims for federally regulated species such as migratory birds and endangered species. Although several States have sought such damages, no State has yet received damages for harm to migratory birds, although Virginia is presently making such a claim for the 1 February 1976 oil spill in the Chesapeake Bay and may be successful in that case.

If both the United States and a State were to claim damages for harm to the same species, the court would of course have to decide which sovereign is entitled to be paid, or how the award should be divided. As the Supreme Court ruled on 24 April of this year, neither the States nor the United States "owns" wildlife in the usual sense of the word. Hughes v. Oklahoma, 47 U.S.L.W. 4447 (24 April 1979). Rather, wildlife is a resource owned by all the people in this country, a resource which the States and the Federal Government have the responsibility to protect. With regard to federally regulated species, the United States is the most logical party to receive damages.

THE PROBLEM OF LIMITED LIABILITY UNDER THE FWPCA

The FWPCA provides that where a spill occurs which may affect natural resources managed by the United States, and where the spiller does not clean up the environment, the United States is authorized to clean up the spill in accordance with the National Contingency Plan. Section 311(c)(1) and (2). The spiller will be liable to the Federal Government for the cost of the cleanup.

However, this liability is limited to certain dollar amounts unless the United States can show that the discharge was the result of "willful negligence or willful misconduct." Section 311(f)(1). In Tug Ocean Prince, Inc. v. United States, 584 F.2d 1151 (2d Cir. 1978), the court construed "willful negligence or willful misconduct" under the FWPCA to mean

> ...an act, intentionally done, with knowledge that the performance will probably result in injury, or done in such a way as to allow an inference of a reckless disregard of the probable consequence .... The knowledge required for a finding of willful misconduct is that there must be either actual knowledge that the act, or the failure to act, is necessary in order to avoid danger, or if there is no actual knowledge, then the probability of harm must be so great that failure to take the required action constitutes recklessness. (citations omitted) 584 F.2d at 1163.

Accord, Steuart Transportation Co. v. Allied Towing Corp., Nos. 77-2426 and 77-2427, 4th Cir., 10 April 1978. The court in Tug Ocean Prince held that the tug's owners could not limit their liability for cleanup costs under the FWPCA because their failure to appoint a captain, to require a lookout, and to inform one pilot of the other pilot's unfamiliarity with the Hudson River met the test of "willful negligence or willful misconduct."

It is clear, however, that the United States will frequently be unable to prove willful negligence or misconduct, and that in most cases the spiller will pay back only a portion of the actual costs of the cleanup. For instance, in the Steuart Transportation Co. case, the cost to the U.S. Coast Guard of removal was $480,000, but because the spiller's liability was limited, only about one fourth was recovered. This may make it difficult to collect damages to natural resources, since the damages for natural resources are presently considered part of the cleanup costs and thus are subject to the liability ceiling in cases where the Government cannot show willful negligence.

One possible solution to the problem of limited liability would be the creation of an emergency cleanup fund large enough to cover the actual costs of oil and hazardous substance cleanups. The Carter administration is presently preparing legislation to require oil and chemical producers to pay up to $6 billion a year into such a Superfund. It remains to be seen if wildlife compensation or restoration funds and methods will be adequate. Unless they are and until and unless such a fund is created, lawyers will have to deal with the problem of limited liability under the FWPCA. One way we have tried to do this is by relying on other sources of legal authority to inhibit spillers or require them to make up the difference between their limited liability under the FWPCA and the actual cleanup costs and damages.

For instance, the Refuse Act, which is part of the Rivers and Harbors Act, 33 U.S. C. §407, provides that it is unlawful to

> ...discharge, or deposit, or cause, suffer, or procure to be...discharged, or deposited...any refuse matter of any kind whatever...into any navigable water of the United States, or into any tributary of any navigable water...

without a permit from the Corps of Engineers. Violation of this provision is a criminal offense punishable by up to 1 year in prison or by a fine of up to $2,500, or both. The Act has been construed to apply to oil spills. E.g., United States v. Ballard Oil Co. of Hartford, 195 F.2d 369 (2d Cir. 1952); La Merced, 84 F.2d 444 (9th Cir. 1936).

Other potential sources of authority for the United States to recover the full amount of damages and cleanup costs are the court-made rules of nuisance and maritime tort. Pollution of navigable waters has long been held by the Federal courts to be a public nuisance because it harms resources shared by all people. Illinois v. City of Milwaukee, 406 U.S. 91 (1972). A maritime tort is simply a civil wrong, such as a nuisance, which occurs on navigable waters and is related to maritime activities. Both of these doctrines, in addition to the Refuse Act, might allow the United States to obtain full recovery for oil spills even where the spiller's liability is limited under the FWPCA.

This argument, however, has not always worked. The United States Court of Appeals for the Fourth Circuit has very recently ruled that the Federal Government can no longer resort to the Refuse Act, nuisance, and maritime tort law in oil and hazardous substance spill cases, but must rely entirely on the FWPCA. This is the Steuart case, where a barge fully loaded with oil sank in the Chesapeake Bay north of the Rappahannock River. Because the United States failed to convince the court that the spiller was guilty of willful negligence, the spiller's liability was limited, and it paid only a fraction of the cleanup costs. Since the court held that the FWPCA provides the exclusive remedy for oil spills, the taxpayer footed most of the bill for this negligent spill. Several other courts have made similar holdings. In re Oswego Barge Corp., No. 76-CV-209 (N.D. N.Y., 13 Nov. 1978); United States v. Dixie Carriers, Inc., No. 77-2090-E (E.D. La., 26 Oct. 1978.

Several courts, however, have held that the United States may rely on legal sources other than the FWPCA to obtain full compensation for cleanup costs. In United States v. M/V Big Sam, 454 F. Supp. 1144 (E.D. La. 1978), for instance, a District Court in Louisiana held that the United States could recover in maritime tort and under the Refuse Act, as well as under the FWPCA, where a collision between a tugboat and a barge resulted in a spill in the Mississippi River. This court discussed the United States' special responsibility to preserve and protect navigable waterways and held that this responsibility gave the United States inherent authority to bring a common law action such as a maritime tort suit. It then went on to construe the language of the FWPCA and its legislative history to show that Congress intended to allow the United States to continue to use the Refuse Act to recover cleanup costs. Other courts have agreed with the Big Sam court. Burgess v. M/V Tamano, 564 F.2d 964 (1st Cir. 1977), cert denied, 435 U.S. 941; United States v. Rohm & Haas Co., 500 F.2d 167 (5th Cir. 1974), cert denied, 420 U.S. 962; United States v. Ira S. Bushey & Sons, Inc., 363 F. Supp. 110 (D. Vt. 1973), aff'd, 487 F.2d 1393 (2nd Cir. 1973).

Thus, the Federal courts disagree on whether the United States can use alternative legal means of obtaining full compensation for cleanup costs when the FWPCA fails to do so. Unless a Superfund is created, as I have already discussed, we may have to resolve this question in the Supreme Court.

THE PROBLEM OF VALUATION OF NATURAL RESOURCES

I would like to talk now about one of the problems that arises when we go to court to recover damages for harm to natural resources such as recreational or esthetic resources or wildlife: the problem of monetary valuation. In order to recover money for these resources, the court must be convinced that the dollar amount that is requested has some rational basis. This is easy when the United States sues for the destruction of an automobile; the cost of the car is known, and how much it will cost to replace it is also a fixed figure. It is not so simple to put a monetary value on the natural resources under the protection of DOI. What does it cost to replace a dead ruddy duck, or even more difficult, an endangered species, such as the brown pelican? A recent spill in Tampa Bay killed at least four brown pelicans.

In some senses these animals simply cannot be replaced, and the harm to the ecology of an area cannot be "fixed." This is why the FWPCA is aimed largely at preventing spills rather than cleaning up after the harm is done. But the Act also gives us authority to sue for damages to natural resources. It is DOI's responsibility to use that authority to maintain environmental values and to see that spillers pay the full bill for damage they cause. We presently are working with the U.S. Department of Justice to arrive at a practical system of valuation for natural resources.

The first problem in valuation of migratory birds is determining how many birds were actually killed. In the case of a recent spill in Virginia, State officials walked along the beach and counted the numbers and species of dead and dying birds. The State then multiplied this number by three, thinking that most of the affected birds would not be seen. Some birds go into areas where humans cannot count them, such as marshes and some birds undoubtedly sank; others were able to leave the immediate area to die elsewhere. Of course, these figures also do not reflect the subtler harm caused by oil, such as a reduced rate of reproduction in surviving birds.

Once we arrive at a number for those birds killed by a spill, a number which is well enough established to hold up in court, it is necessary to decide how much money to request for each individual. In the Oswego Barge case, this figure was based on the cost of replacing the individual birds, by capturing individuals of the same species elsewhere. Considerations used to calculate this cost included: account hours of work, the cost of experts, transportation, special facilities, lab tests, research studies, and special equipment used to capture the birds. The amounts requested were $25.00 per Canada Goose, $30.00 per Northern Green Heron, and $10.00 per Mallard Duck, which added up to a total cost of $60,560.00. Some people feel that even these figures are unrealistically low.

Similarly, the court awarded the Commonwealth of Puerto Rico damages for the destruction of mangroves based on the cost of replanting the spill area in Commonwealth of Puerto Rico v. S.S. Zoe Colocotroni, 456 F. Supp. 1327 (D. P.R. 1978). The Commonwealth also received compensation for marine animals killed by the spill. Replacement cost was based on the market price of the organisms, which had a market value because of their use in biological supply laboratories. Using the lowest possible cost of $0.06 per animal, the court awarded the Commonwealth $5,526,583.20 for the organisms.

The problems with the "replacement" approach to valuation can be enormous, however. Many species cannot simply be captured and relocated. Capture would merely create a drain on populations elsewhere. Most species cannot be bought on the open market, or if they can, will not survive in the wild. Many species cannot be raised in captivity in large enough numbers to be of any use, or cannot be raised at all.

Another method that has been suggested is to determine how much a hunter actually pays to bag a particular bird, taking into account all expenses such as equipment, fees, and travel. Of course, this approach is useless for species that are protected from hunting, and does not reflect what it will cost to replace the bird.

A somewhat different approach to valuation is to focus on a species as a whole rather than on the individuals killed, and ask for damages to cover the cost of programs to benefit the overall population. For instance, we could ask for money to buy enough breeding or wintering habitat elsewhere to produce enough birds to replace those killed by the spill.

One point that should be made about suing for money damages is that this really does not help the environment in any direct way. The money goes into general funds, which may be good for the national treasury, and may help deter people from spilling, but which does not repair the harm to the area where the spill occurred. This is why we are trying to encourage spillers, under court order, to actually replace or repair the destroyed resource themselves rather than just giving money. In addition, there are several court decisions saying that in cases where the Government could obtain an injunction forcing a defendant to carry out certain actions, it has the alternative of repairing the harm itself and then sending the defendant the bill. Recent drafts of the Superfund legislation would allow access to the fund for the loss of natural resources.

OTHER SANCTIONS AGAINST SPILLERS

Now I would like to discuss for a few minutes some of the other actions that can be taken against those spillers who harm or kill migratory birds or endangered species. There is presently a trend in the U.S. Department of Justice to criminally prosecute individuals as well as corporations for violations of Federal pollution statutes (See Norton F. Tennille, Jr., "Criminal Prosecution of Individuals: A New Trend in Federal Environmental Enforcement?" ALI-ABA, (1978.)

Under the Migratory Bird Treaty Act, 16 U.S.C. §703, it is unlawful to

> ...at any time, by any means or in any manner, to...take, ...or kill,...any migratory bird, any part, nest, or eggs of any such bird, ...included in the terms of the conventions between the United States and Great Britain, ... the United States and the United Mexican States, and the United States and the Government of Japan for the protection of migratory birds and birds in danger of extinction ...

A violation of this broadly worded prohibition is a criminal offense, 16 U.S.C. §707, punishable by a fine of up to $500.00, imprisonment for up to 6 months, or both. Most North American birds are covered by the Act.

Similarly, the Endangered Species Act, 16 U.S.C. §1538, forbids the taking of endangered or threatened species, and defines "take" broadly to include "harm." FWS's regulations define "harm" to include

> ...an act or omission which actually injures or kills wildlife, including acts which annoy it to such an extent as to significantly disrupt essential behavior patterns, which include ...breeding, feeding, or sheltering; significant environmental modification or degradation which has such effects is included within the meaning of "harm." 50 C.F.R. §17.3 (1977).

This Act also provides criminal and civil penalties for taking listed species.

Several other statutes contain similar provisions: the Bald Eagle Act, 16 U.S.C. §668; and the Marine Mammal Protection Act, 16 U.S.C. §1375. Both Acts provide criminal penalties of up to a year in jail as well as civil penalties.

The important point about all of these statutes is that they provide criminal and civil penalties for spillers who harm protected species. Since the Migratory Bird Treaty Act protects almost all native North American birds, virtually any spill which harms any bird will be a violation. Furthermore, this Act has been very broadly construed by the courts to allow criminal penalties for unintentional or negligent takings.

In United States v. Corbin Farm Services, 444 F. Supp. 510 (E.D. Cal. 1978), aff'd in part, 578 F.2d 259 (9th Cir. 1978), three individuals were charged with criminal violations of the Migratory Bird Treaty Act. One was an employee of a company which distributed pesticides who advised farmers on pesticides to get them to buy his company's products. Another was the owner of an alfalfa field who had his property sprayed, and one was the actual sprayer. The spraying killed 12 American widgeons, a species protected by the Migratory Bird Treaty Act.

The defense was that the three individuals did not know birds used the field and did not intend to harm them, and that the Act does not allow criminal penalties for unintentional killing. The court rejected this reading of the Act, holding that all the Government needed to show was that the defendants sprayed the pesticide and that this action caused the deaths. The defendants should have determined whether birds were feeding in the field before they sprayed

> ...When dealing with pesticides, the public is put on notice that it should exercise care to prevent injury to the environment...the MBTA can constitutionally be applied to impose criminal penalties on those who did not intend to kill migratory birds...444 F. Supp. at 536.

This reasoning certainly applies to those who handle oil or hazardous substances. These individuals are clearly subject to jail sentences for negligent spills which harm protected birds.

Other courts have taken the same approach. In United States v. FMC Corp., 572 F.2d 902 (2d Cir. 1978), the defendant was convicted of 18 counts of violating the Migratory Bird Treaty Act, and the court imposed a $100 fine for each count. The defendant manufactured pesticides and unintentionally allowed a pesticide to leak into a pond. Ninety-two birds were killed when they landed on the pond during migration. This case was different from the Corbin Farms case in that the defendants in FMC Corp. were liable not for an action which harmed birds, but for an omission; the failure to prevent leakage.

The court held that because the defendants were engaged in an extrahazardous activity, the production of a dangerous pesticide, they would be held strictly liable for harm resulting from their operations. Thus, even where defendants are not actively negligent, they can be held criminally liable for harm to migratory birds. This rationale also is applicable to those who deal with oil and hazardous substances. These individuals can be criminally prosecuted for any spill that kills protected birds.

It is highly likely that this will hold true for other protected species, such as endangered or threatened species or marine mammals, as well as migratory birds. For instance, the Endangered Species Act clearly is intended to cover negligent takings. An oil spill which degrades an environment used by endangered species would be a violation of the Act if this degradation had the effect of disrupting the species' breeding, feeding, or sheltering. Thus, if the spill did not directly harm an animal, even if the animal were in another area of the country at the time of the spill, the spiller could be liable if the animal eventually were affected by the harm to the spill area.

CONCLUSION

To conclude, I would like to reiterate that the Federal Water Pollution Control Act, the Refuse Act, maritime tort law, and the common law of nuisance are all potential tools to force spillers to pay for the harm they cause. The civil and criminal penalty sections of the Water Pollution Act, the Migratory Bird Treaty Act, the Endangered Species Act, the Bald Eagle Act, and the Marine Mammal Protection Act are tools that can be used to punish spillers and perhaps deter them. DOI has both the authority and the responsibility to use these tools, for Congress has explicitly declared it as trustee of the natural resources formed in lands which DOI manages. Although new legal ground is being broken with our claims for damages to natural resources, DOI's authority is clear. DOI has the power to make spilling of oil and hazardous substances on Federal lands a costly error, so users will perhaps be more careful. When spills occur, DOI has the power to do as much as is physically possible to ensure that these resources are restored.

FISH AND WILDLIFE SERVICE POLLUTION RESPONSE PLAN FOR OIL AND HAZARDOUS SUBSTANCES

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INTRODUCTION

The Fish and Wildlife Service (FWS) is responsible for the protection, conservation, and enhancement of fish and wildlife resources and their habitats through the Endangered Species Act, Migratory Bird Treaty Act, Fish and Wildlife Coordination Act, National Wildlife Refuge Act, Anadromous Fish Conservation Act, Great Lakes Fishery Act, Marine Mammal Protection Act, and other Federal laws. The FWS manages migratory bird populations and fisheries through an extensive network of National Wildlife Refuges and National Fish Hatcheries; and provides through its various Offices and Divisions technical assistance to other government agencies, industry, academic institutions, and private citizens to promote conservation and preservation of fish and wildlife resources and their habitats.

Oil spill incidents occur at a frequency of 10,000 annually in the United States (USCG 1978). Though the number of hazardous substances spills is not readily available from current statistics, a recent report by the Senate Committee on Environment and Public Works estimates approximately 3,500 incidents involving chemicals on an annual basis (1978). Approximately 1,700 of these spills reach navigable waters each year.

Incidents of oil and hazardous substances spills tend to be most frequent in areas that sensitive fish and wildlife populations inhabit or those where abundant populations once resided. The FWS expends considerable effort to preserve sensitive fish and wildlife habitats from land and water development and energy production activities; however, these habitats remain vulnerable to accidental spills. Included are those habitats which are noted as important spawning areas for fish, those critical to endangered species, and those essential to migratory bird populations.

AUTHORITIES AND RESPONSIBILITIES

Oil and hazardous substances spills intrude upon the mandates of many Federal, State, and local agencies. The "National Oil and Hazardous Substances Pollution Contingency Plan" (40 CFR 1510) provides a mechanism for coordinating Federal, State, and local actions to minimize damages from oil and hazardous substances pollution discharges. These actions include containment, dispersal, and removal of the pollutant. The plan also provides for protection and conservation of fish and wildlife populations and their habitats.

The U.S. Department of the Interior (DOI) has been assigned major responsibilities under the National Contingency Plan. DOI is a primary member of the National Response Team (NRT), Regional Response Teams (RRT's) and Local Response Teams. In accordance with provisions of the National Contingency Plan, the FWS published its Pollution Response Plan for Oil and Hazardous Substances in 1977. This plan has been augmented by the development of FWS Regional Pollution Response Plans. I shall highlight the provisions of the FWS Pollution Response Plan.

FWS POLLUTION RESPONSE PLAN

The Pollution Response Plan provides guidelines for meeting FWS responsibilities under the National Contingency Plan. Guidance is provided within a matrix to augment rapid decisionmaking for the protection and conservation of fish and wildlife resources and their habitats during pollution emergencies.

FWS Pollution Incident Notification and Coordination

The pollution incident notification and coordination process is perhaps the most important aspect of the Pollution Response Plan. Once the FWS is notified of a pollution incident it is imperative that the appropriate personnel are advised of the potential threat to fish and wildlife resources and habitats immediately.

Figure 1 provides a flowchart of notification and coordination pathways for FWS response to pollution incidents. This illustration provides for a tiered notification and coordination pathway limiting the number of contacts necessary by the Field Response Coordinator (FRC), Regional Pollution Response Coordinator (RPRC), and the National Pollution Response Coordinator to a manageable number in view of the plans which they may need to implement to protect and conserve fish and wildlife resources. Regional Pollution Response Plans have been developed to facilitate the coordination of FWS activities during spill emergencies within each FWS Region.

Responsibilities of FWS

Although prevention is recognized as the best method for reducing impacts to fish and wildlife resources and their habitats from oil and hazardous substances, additional spill incidents are likely to continue at high levels. The FWS involves itself in prespill planning and actual spill response to limit the impacts of oil and hazardous spills on fish and wildlife resources. The responsibilities of the FWS once spill incidents occur and

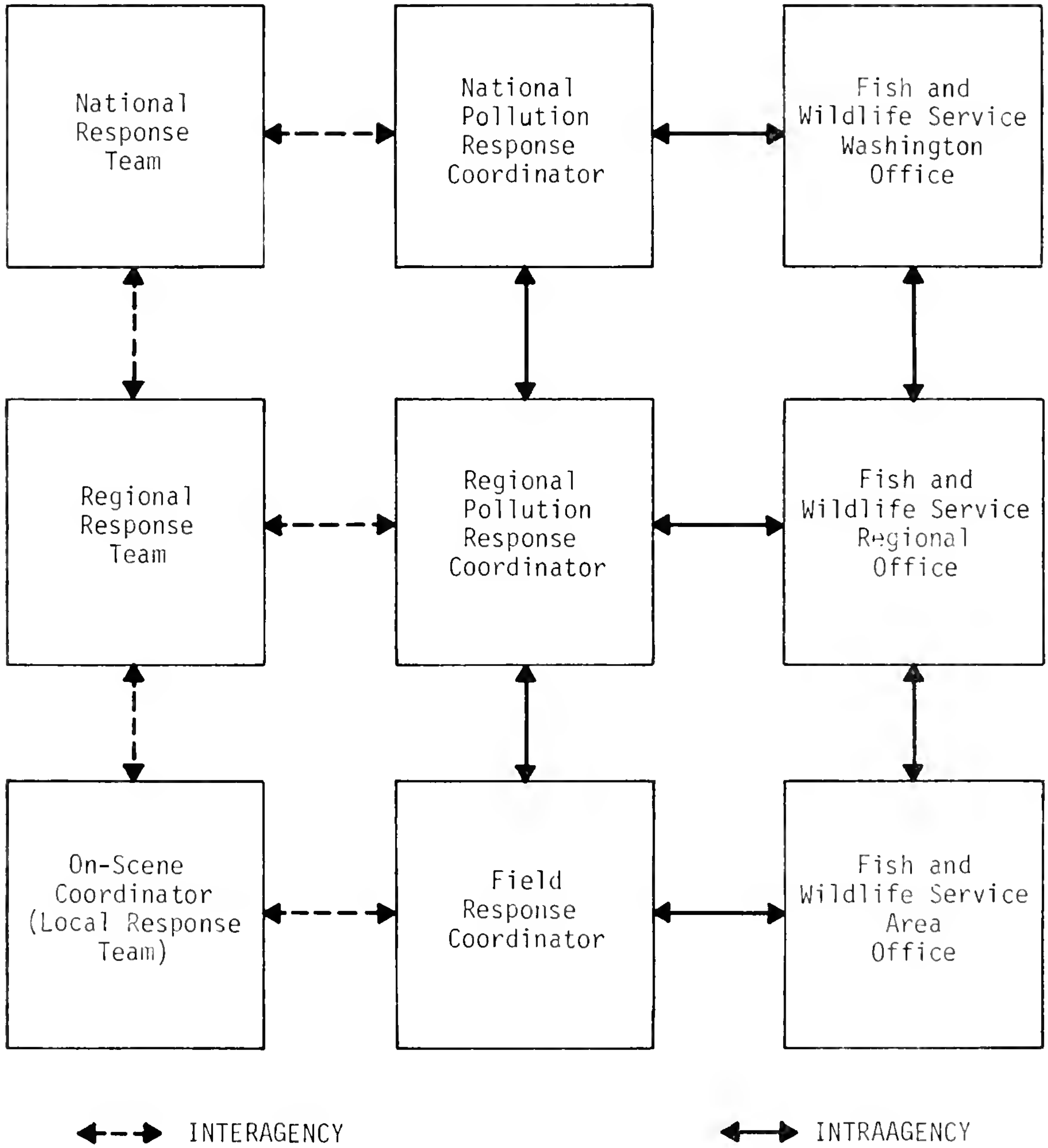

Figure 1. Flowchart of notification and coordination pathways for Fish and Wildlife Service response to pollution incidents.

also in the planning process may be summarized as follows: to provide a member or alternate member on the NRT and RRT, to develop and implement regional response capabilities for the protection of endangered species, wildlife, and fisheries resources and their associated habitats; and, to coordinate Federal response activities should a FWS representative be the first Federal person on the scene.

It is often necessary for FWS personnel to temporarily coordinate Federal response to spills when incidents occur on lands managed by the FWS or when spills occur in areas in which a FWS representative is the closest Federal official.

The FWS shares additional spill responsibilities with the States and other Federal agency representatives. In cooperation with State and other Federal agency representatives the FWS has responsibility: to prepare for, oversee, and/or implement dispersal of wildlife from areas contaminated by or threatened by pollution discharges; to determine how, by whom, and where contaminated endangered species and wildlife under FWS jurisdiction will be handled in the event of a spill; to provide the On-Scene Coordinator (OSC) with recommendations of actions for protection of fish and wildlife resources, including, but not limited to endangered species, migratory birds, marine mammals, estuarine and inland fisheries and their habitats; and, to assist in documenting environmental damage caused by oil and hazardous substances discharges for use in legal actions and in predicting impacts of future discharges.

Criteria for FWS Response

The number of spills occurring in U.S. waters far exceeds the capability of the FWS to respond to all incidents. Criteria have been developed for response actions that will provide the necessary protection of fish and wildlife resources and their habitats during pollution emergencies. Through pre-spill planning we are able to respond to these spills in which sensitive fish and wildlife resources stand to be damaged and where populations stand to be jeopardized.

The FWS responds to all major oil spills and others in which there is potential for impacts to natural resources. The size classes of oil spills are noted in Table 1. The size classification of a spill may be elevated by its relative threat to the public health which includes fish and wildlife. The size of a spill alone is not indicative of the resulting threat of damages to fish and wildlife resources and habitats. The nature of the oil, the time of year, the location of the spill, climatological factors, and other elements will affect the vulnerability of fish and wildlife resources and habitats to oil spills.

Table 1. General size classes of oil spills.

Size	Inland waters	Coastal waters
Major	10,000 gallons or greater	100,000 gallons or greater
Medium	1,000 to 10,000 gallons	10,000 to 100,000 gallons
Minor	less than 1,000 gallons	less than 10,000 gallons

Hazardous substances spills pose an added dimension for FWS response. Due to human safety considerations the extent of response by FWS employees must be on a case-by-case basis. No FWS employees are authorized to jeopardize their lives unnecessarily. In many of these incidents our technical advice will have to be limited to distal verbal communications with the OSC and the appropriate RRT. When the hazards to human safety do not exist we must be onscene to advise when fish and wildlife resources and habitats are jeopardized.

Priorities for FWS Response

The FWS first priority for spill response is the protection of endangered species and their habitats. Where advisable, the rescue and rehabilitation of individual animals will be provided for.

The second spill response priority is to engage in activities necessary to minimize the direct and immediate impacts on susceptible fish and wildlife populations for which the FWS has management responsibilities.

The FWS third spill response priority is to oversee the collection and treatment of oiled birds. The public demands that the FWS actively pursue this.

The fourth priority, and not least, is to provide the news media and the general public information on fish and wildlife concerns during spill incidents. The FWS shares this responsibility with all agencies involved in responding to spill incidents to work together in providing up-to-date, accurate information corroborating a realistic picture of the problem.

The need for response by FRC's should be based upon all of the preceding priorities. FRC's should always respond to incidents which involve or threaten endangered species, marine mammals, migratory birds, or other resources that are under the management responsibility of the FWS. Rational choices must be made in the interpretation of this plan. Through participating in regional and local contingency planning and identifying key concerns in local plans early on, these priorities will remain clear and fewer emergency decisions will have to be made. As a result, less time will be required for FWS response.

Cost Recovery, Reimbursement, and Documentation

The primary responsibility for cleanup resides with the spiller. If the spiller is doing an adequate job of cleaning up, then the FWS's role is limited to monitoring. Under these circumstances the FWS has to utilize its resources and funding to protect, conserve, and enhance fish and wildlife resources. The FWS Program Managers have all agreed that this is a worthwhile cost to be absorbed. It is also an incentive for polluters to clean up their spills.

If a spill occurs, and Federal or partial Federal cleanup is necessary, reimbursement from the National Pollution Revolving Fund may be authorized by the OSC. Such expenditures as per diem travel, overtime, equipment, and supplies are covered by the Revolving Fund in accordance with 33 CFR 153. Additional expenditures may be granted with prior approval from the OSC.

The FWS has a responsibility to document all of its costs during spill incidents in addition to noting environmental damages. Such information is essential to receiving reimbursement for FWS expenditures on Federal spills but, more importantly, to assess the spiller for damages incurred. As stated in the preceding presentation, it is this information that is collected during the time of spill response that is of utmost concern when legal cases are pursued against spillers. The FWS has a responsibility to record its actions during its response to pollution incidents so that they will be defensible later.

CONCLUSION

The FWS responded to over 350 oil and hazardous substances spills during Fiscal Year 1978. As of this workshop the FWS had already exceeded that number during Fiscal Year 1979. This is testimony to the need for more involvement by the FWS in responding to oil and hazardous substances spills and the commitment to be on the vanguard in protecting natural resources. The implementation of the FWS Pollution Response Plan has undoubtedly contributed substantially to sustaining the quality of sensitive fish and wildlife habitats for continued uses by populations that require them.

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ENVIRONMENTAL RISKS OF TRANSPORTING HAZARDOUS MATERIALS: INDUSTRY'S APPROACH

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My remarks today represent the policies of Seaboard Coast Line Industries only, and not the entire railroad industry. Our company operates in 13 States and deals with the geographical conditions in these specific areas. Railroads in other parts of the country deal with different geographic conditions and their responses to hazardous materials need to be different.

As to the railroads' view of the environmental impact of an oil or hazardous materials spill, Seaboard Coast Line Industries (SCL) faces unique problems during accidents due to the populous centers that our railroad serves. In addition, the water table is potentially, immediately, and severly impacted in the States where we operate. Railroads in the Western States have hazardous materials accidents and return to operation within hours. It takes us days to do the same.

Some people may think that our firm is insensitive to the environmental aspects of these incidents. In the past, this may have been the case. However, now there is demonstrable evidence that our firm is very concerned about the impact of the accidental release of hazardous materials. SCL employs specialized personnel who respond to accidents in order to address these environmental problems. Laboratories are hired to accurately assess the types and amounts of materials spilled and where the runoff will carry them. We prefer to split samples with State and Federal agencies to assure that everyone is working from the same data. With the news media reporting the happenings from the scene of the incident, it is imperative that the information being released is accurate.

SCL recognizes that it cannot control what information the public receives; however, the company can influence the information the media gets. Yet, the company does not attempt to cover up any information because truth in dealing with these matters is essential. The company is proud of the integrity it has established. Inaccurate information in these instances results in unacceptable consequences to the public. Water supplies, food supplies, livestock, gardens, and pets all can appear to be threatened from the public's point of view, when in reality, the only thing that is exaggerated is the media report.

As concerned individuals, we should not allow anyone to damage the environment. As good citizens, we would not knowingly do this. However, the media often creates an atmosphere of over reaction among their listeners and readers. During a derailment our firm is under extraordinary stress to effectively deal with the hazardous materials. An inordinate additional amount of stress on our personnel is created by the media. Elected officials who must protect the well-being of the citizens create stress due to their lack of understanding of the ability of the railroad to assist them in protecting the citizenry. Government and industry can reduce this unnecessary stress by coordinating all investigations, problemsolving efforts, and public statements.

There have been enough accidents with resultant release of product to indicate that one of the most visible problems is created by the questions: "Who is in command?" "Who is responsible?" "Who has authority?" These questions are like a plague that besets these accidents. Local, county, State, Federal agencies--each knowing that it has a responsibility, but not realizing what specific functions the others have--go about doing their own things. This confusion must be overcome. As many as 45 people, representing different (and sometimes the same) agencies, have claimed the command authority. Imagine the plight of the railroad, being confronted with command decisions issued by all these different agencies. A derailment with product release is tough enough to deal with, but this is ridiculous! Each agency is charged with unique responsibilities, and our company is sensitive to the need to satisfy their demands. The Regional Response Team (RRT) is the vehicle that can bring logical order to this confusion.

Here is an example of a hazardous materials spill situation. At about 8:00 a.m. on 8 April, a 117-car train derailed outside Crestview, Florida. Within minutes, the fire chief had hazard information for each product on board. It was determined which cars were involved and what product each contained. Shortly after the derailment, an explosion took place. Some 20 minutes after the derailment, a second explosion was reported. Up to this point, events within the derailed cars were happening without warning. Simultaneously, the emergency response personnel were taking correct actions regarding evacuation of area residents. But, this is where the actions at Crestview greatly differ from those taken during many other similar incidents.

The fire chief decided not to commit his personnel to fight the fires or cool tanks. From a safety view, this was the most intelligent decision he could make. Believe me, this decision was difficult to make.

Environmentally, things generally stacked up as follows: 16 anhydrous ammonia cars, 1 urea, 1 sulfur, 1 carbon tetrachloride, 3 acetone, 4 methyl alcohol, 1 chlorine, and 1 carbolic acid (phenol). The two explosions sent the ends of two anhydrous ammonia cars some 400 feet away on one side and 500 to 600 feet on the other. The sulfur was partially gone; some still burned. The chlorine car had been punctured with a large amount of product released. Three to five anhydrous ammonia cars were leaking with varying degrees of severity. To put this in perspective, the incident was within 200 feet of the bank of the Yellow River. Seven different products had been released. After determining that everyone had been evacuated, the main concerns were: a) personnel safety, b) the environment, c) restoration of the railroad, and d) restoration of normal community activity, but not necessarily in that order.

By early afternoon, many other cars on the trestle needed attention because it was burning at one end. These cars had to be removed from the area of fire exposure. Otherwise, we would risk Liquid Petroleum Gas (LPG) and other products becoming involved. During an earlier overflight of the area, heavy equipment had been seen at a sawmill. Locomotives were 2 to 3 hours away in Pensacola. Thus, to avert expansion of the situation, we used the log moving equipment to pull all but two of the remaining cars off the trestle.

Two methyl alcohol cars still remained on the burning trestle. Seven individuals went out on the trestle to extinguish these fires. While working their way toward the derailment on the opposite bank which was about 200 feet away, the seven railroad employees and fire fighters encountered an unexpected event. One of the lazily venting anhydrous ammonia cars suddenly released product 50 to 70 feet in the air. About 15 seconds later, one of the acetone cars released all of its product with flames going some 70 to 90 feet in the air. This example briefly describes the complexity of hazardous materials accidents.

During the following days, the efforts of all the agencies were commendable. Levelheaded, practical people represented the environmental agencies. No unrealistic demands were made on the railroad by agency people. Our company participated in the decisionmaking, which enabled us to give those agencies ample time to consider and prepare for the implementation of the approved plans. It was a pleasure working with most of the people involved.

The railroads will work with you. They will clean up their spills. They will work as hard as humanly possible to mitigate the problems. However, your perception of the railroad's cooperation will be affected by the degree of coordination of all organizations involved. Therefore, I ask only two things: 1) organize and plan your responses, and 2) promote the RRT concept with all government agencies involved.

Government agencies need citizen support during a hazardous materials spill. Our company wants to support the Government's position by approaching spills with an organized and coordinated response that involved all concerned agencies. Safety to life is paramount. Through interagency coordination and participation, hazardous materials spills can be approached more efficiently and effectively.

CHEMTREC—AND CHEMICAL EMERGENCY RESPONSE

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Early one morning, three cars of phenol were among those in a derailment in the hills of western Maryland. All three cars were punctured. Phenol spilled out onto the ground where some of it flowed toward a creek. As the phenol spread, it began to solidify. This is quite normal, in view of its melting point of over 100°F. The problem was not an easy one, but it was controllable. However, with their normal philosophy of applying water to any emergency, and with some poor advice from a neighborhood "expert," the fire services began to wash the material down to get rid of it. As the watershed involved ultimately led into the Potomac River, there was considerable concern among the authorities regarding the safety of the Washington water supply. Fortunately, minimal damage occurred. Most of the spilled product was hauled back to the point of origin.

This occurred in the early days of Chemtrec, the Chemical Transportation Emergency Center. Then, the railroad and emergency services did not make use of an available resource. However, the shipper was notified by the railroad. He had experts on the scene in a relatively short time. Obviously, the railroad, as the carrier involved, was the "spiller" of the material. He was responsible for getting the material cleaned up and for eliminating the potential damage to people and the environment. The shipper was quite concerned about the outcome of this situation. He put representatives on the scene as rapidly as possible to offer knowledge of the product that only a shipper was capable of providing. Chemtrec, as a central communication point, is designed to provide immediate response information and to notify shippers, enabling them to bring this expertise into use.

Before the operation began, it was recognized that the emergency services and carriers would be calling for help on hazardous and nonhazardous materials, whether "chemicals," petroleum, explosives, or any other category. When carriers have trouble, they call. Thus, Chemtrec planned for, and does receive calls for information and help on the entire gamut of cargoes. As evidence of the ridiculous extremes to which some people go, a call was received regarding a load of chickens which had escaped in a truck accident. The man wanted help in rounding them up.

In working with the emergency services, it has long been evident that the police have little knowledge of hazardous materials. The fire services basically are oriented to structural fires, although many have some knowledge of handling gasoline and fuel oils, simply because of the frequency that they meet them. Most, however, have little or no knowledge of what to do when they encounter the vast range of hazardous materials that are shipped by our industries. This is particularly true of the smaller volunteer fire departments, although it does pertain frequently to the larger professional departments as well. They generally are not prepared to identify the materials involved, and rarely have training in how to handle these materials once they are leaking or burning. Too often, they simply apply water.

The same problem applies to carriers, although some tank truck drivers on steady chemical or petroleum runs may be aware of the nature of their cargo and possibly have some guidance as to handling of the products. In general, carrier personnel are completely untrained in handling leaks or fires involving the products they are carrying.

Recognizing these problems, the Chemical Manufacturers Association (CMA) (formerly Manufacturing Chemists Association) in 1964 created the first Chem-Cards which were oriented to assisting carriers and emergency services in the handling of specific products. There were about 90 of these cards prepared. The format was the forerunner of many transportation guides currently in use. In the 1960's, CMA studied the needs for communications to emergency services and carriers, and made recommendations to the Department of Transportation (DOT) regarding a hazard information system. During this study, the concept of emergency telephone communications was reviewed; however, the idea had not reached its time, and nothing further was done with it until later. Following the Dunreath, Indiana derailment of 1968, the National Transportation Safety Board recommended that DOT establish a communications system whereby the emergency services could get advice and guidance on the handling of hazardous materials. At that time, the DOT approached CMA to see what the chemical industry could do in this regard. A study group was formed. The outcome of this was the recommendation to the Board of Directors that a center be established in Washington to perform this function. Chemtrec was approved in June 1970 and became operational on 5 September 1971. It is financed entirely by the CMA. Its services are available at no charge to carriers, emergency services, and others who have need. Publicity on the operation has been restricted to those who have need to know, and has been concentrated in the emergency services, carriers, and the chemical and associated industries.

Chemtrec is based on a two-step concept. First, on receipt of information regarding a chemical involved in an incident, the communicator transmits immediate information of the Chem-Card level from prewritten files. This file information is provided by the shippers of the materials. This is short, concise information on the nature of the product, and its hazards, and guidance for actions in case of spill, leak, fire, or exposure.

Once this information has been transmitted, the communicator then takes immediate steps to determine and make contact with the shipper, or other expertise, who then provides additional advice, and if necessary, onscene assistance to those involved in the incident. Obviously, the latter is needed in a relatively small percentage of the incidents.

Chemtrec can be reached from any point in the continental limits of the United States by dialing 800-424-9300. In the District of Columbia, it is necessary to use a separate number, 483-7616. With the addition of the area code, this becomes 202-483-7616, for use in Alaska and Hawaii, the territories, Canada, and in fact, anywhere in the world. It is common to receive a call from the London Fire Brigade, which is responsible for Heathrow Airport, outside of London. Chemicals in transit can occasionally cause problems, and it is sometimes easier for shippers to call here than to seek guidance within the United Kingdom. Shipper's response to these calls has been excellent.

Chemtrec recommends that shippers mark their bills of lading to show the emergency statement and the phone number. The standard format is: "For chemical emergency--Spill, leak, fire, exposure, or accident--Call Toll free, day or night, 800-424-9300." Shippers doing this obviously must be registered with Chemtrec, providing their emergency contact telephone numbers. In addition, there are currently available printed vinyl panels to be placed on tank cars and tank trucks to show the Chemtrec number. We urge shippers and carriers to make use of these to provide guidance to emergency services. These panels can be obtained commercially from two separate firms which are producing them.

When an incident occurs, a call to Chemtrec usually comes from a carrier, from a fireman, or a policeman. The call on the "800" number goes to the Chemtrec communicator, who obtains the essential information. This includes the caller's name and organization, his callback number, the products, the problem, the location, the shipper, and carrier. Chemtrec has its own form for this purpose which includes other additional data which are desirable to have under certain circumstances.

When the essential information has been obtained, the communicator turns to his files and pulls the appropriate card concerning the product involved. He then reads the pertinent information to the caller, giving such portions of the card information as are needed. Products on file are in alphabetical order, on cards which can be accessed in a matter of seconds. The information provided is intended to provide guidance for the early stages of an accident in an effort to prevent the situation from becoming worse.

Once the card or other information available from the file has been transmitted, the communicator goes through the second step, which is locating the appropriate person in the shipper's, or other organization, to provide the expertise needed to bring about a quick resolution of the problem. This person can be a plant manager, a production superintendent, a technical services representative, or anyone in the organization who handles the product regularly, and is capable of providing the necessary assistance. This is a primary strength of Chemtrec. No other resource in the country can compare to the product knowledge available from those who produce and ship a product on a daily basis.

When Chemtrec was started, it was recognized that while CMA member companies would be a very important portion of the activities, (and today 75 percent of the transportation incidents handled involve member companies), there was a definite need for a mechanism to access those who may not be members. There are currently listings for emergency numbers on over 500 non-member companies in the file. When the shipper is not listed, a variety of efforts are made to establish contact. The first, and simplest, is to call the information operator in the city or town where the company is reportedly located. This location usually can be obtained from labels, shipping papers, or from reference documents available in the Chemtrec office.

If no one is accessible in this way, the communicator will then call the fire or police headquarters in the town, and ask for help, based on their preplans. This frequently is a very useful approach. As a last resort, the emergency services will be asked to send a car to the location of the facility to determine what information might be available on the main entrance. Again, this has been a successful method.

There are frequent occasions when the only information available is a tank car number, or "reporting mark." A mechanism is needed to convert this into product and shipper information. When the mark is a "Dowx," or "Celx," it is easy to relate to Dow or Celanese. If it is "Gatx" or "Shpx," however, a leasing company is identified, rather than a shipper. By agreement with most leasing companies, including all the major ones, 24-hour service is available to provide the name of the leasee to permit prompt development of the needed information. As a result, Chemtrec keeps a file of reporting marks, so if a tank car is located on a siding and the bottom outlet is leaking, or the relief valve is releasing, appropriate action can be taken.

An essential element of Chemtrec is the ability to access emergency response organizations, other than shippers. Such cooperating groups include trade associations, carriers, and government facilities. The Chlorine Institute operates The Chlorine Emergency Plan, in which a specific producing plant is responsible for emergency response within a given geographic sector. Teams are organized and equipped to move out on instant notice. They handle matters ranging from leaking cylinders up to tank cars. These groups are well organized and very responsive.

The National Agricultural Chemicals Association maintains a Pesticide Safety Team Network. It too has a regional organization, responsive to pesticide problems.

Within the chemical industry informal mutual assistance programs are organized for certain products. For several years, the vinyl chloride manufacturers (VCM) have had the VCM emergency plan. Within this plan, the manufacturers or users of the product notify Chemtrec of their intention of participating in the program. When an incident occurs, Chemtrec notifies the shipper, who will respond if he can so do effectively. Alternately, he will ask for the name of the nearest team and will activate that team. In the case of an unknown shipper, Chemtrec can call on the nearest team to provide the necessary assistance.

The hydrocyanic acid producers have been participating in a mutual assistance plan for a number of years, and also will respond to each others needs.

Mutual assistance programs have proved to be very valuable to industries shipping hazardous materials and should be expanded greatly.

In the case of radioactive materials, Chemtrec notifies the appropriate regional office of the U.S. Department of Energy. It then takes responsibility for the problems.

The original, and current, concept of Chemtrec called for the two-step program of providing prewritten information, and activating appropriate expertise. It was realized that no one individual could have the knowledge to handle all the products with which Chemtrec would be involved. As a result, the communicators are not technically trained, but were chosen for their ability to remain cool, to be dedicated, disciplined, and to be efficient in communications. For this reason, the center has been staffed with retired military personnel. In 7.5 years of operation, this has proven to be an effective means of staffing.

In the 7.5 years since the inception of the program, Chemtrec has received over 83,000 telephone calls, of which 28,200 involved emergencies. From this, Chemtrec provided information or assistance in over 13,600 emergencies. At the inception of the program, we anticipated that the predominate activity would come from the emergency services. As it turns out, they average about 18 percent of the initial calls coming into the center. After several years of operation, we have learned that this is to be expected. When a trailer arrives at a loading dock, and the doors are opened, it is not the firemen who see the leaking drum; it is the dock foreman, or the dock hand. When a tank car blows a rupture disc, or has a leaking relief valve, the railroad yard employee makes the discovery, not the emergency services man. Therefore, it is quite logical that 75 percent of the initial calls come from carrier personnel through a dispatcher.

When Chemtrec was approved 9 years ago, not many of the ideas of regulation or attitude regarding the environment that are present today existed. The primary thrust of the program was to protect people and to a lesser extent, property, and the environment. People continue to be our priority; however, environmental considerations have grown greatly in the program in subsequent years.

A continuing problem, as evidenced in the opening example, is the heritage and training of fire people who believe that water is a solution to everything. Following a recent pesticide warehouse fire, Chemtrec was called and told the fire service had large quantities of contaminated water, and asked what should be done. Preplanning of such incidents with the property owner, the fire personnel, environmental people, and perhaps even insurance companies could have substantially changed the outcome of several of these incidents that have been reported.

As mentioned earlier, in most transportation situations the liability for cleaning up a spill rests with the carrier. On some occasions, the carrier is the shipper, who uses his own private transportation. In the vast majority of the cases, however, the carrier is a transportation company, such as a railroad, trucking company, or barge line.

This comment does not imply in any way that the shipper does not have concern. The entire emergency response system as established by the chemical industry and others, and as coordinated by the communication system of Chemtrec, is predicated on the shipper having a positive interest in protecting people and the environment to such extent as he can.

In many instances, this support of the emergency services of those involved can be handled by telephone. It must be realized at this point that the majority of the incidents handled on a day to day basis are not the type of thing that involves the environmental contingency plan. Most incidents are the pesky little problems that bother truck drivers or rail yard operators and consist of small quantities of material released either through a leaking drum or valve on a car, a broken rupture disc, or any of the numerous things that happen where the quantities of the material involved are small but where the concern to the uninformed individual with whom they are in contact is great.

In reviewing the proposed environmental regulations, the reportable quantities vary from 1 pound of the very bad materials up to 5,000 pounds of some of the less troublesome products. In the typical drum problem, the situation is one of a leaking container which will usually contain less than 500 pounds of material.

A typical tank car leakage problem will often involve small quantities of vapor or liquid escaping through an open vent valve or a leaking bottom outlet. Again, this is in terms of pounds and gallons rather than reportable quantities of most products.

However, when the serious incidents do occur, it is quite important that those individuals who are involved in such activities notify Chemtrec for two reasons. First, if it is a product on which one has little or no information, Chemtrec normally can provide immediate action guidance. Secondly, companies want to be notified of such incidents, and Chemtrec in turn, has this capability. To summarize Chemtrec's interest in the problem when spills occur, it is important that correct steps be taken as rapidly as possible. It is important that the shipper or manufacturer be notified so he can contribute his expertise to assist in resolution of the problem.

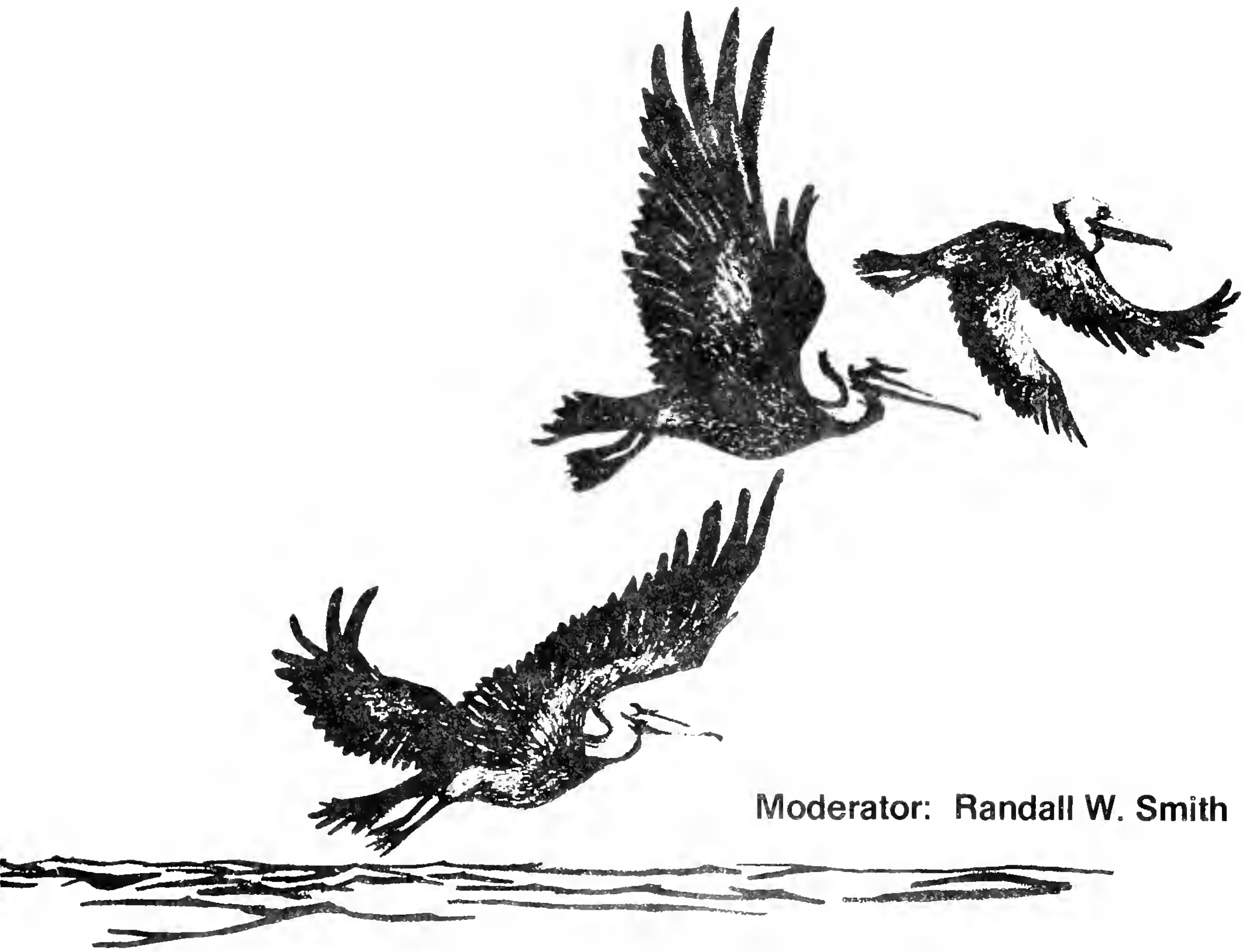
Shippers often can bring analytical tools into use where they are needed to assist in determining the extent of the environmental damage. If a load of oil is spilled, it is fairly evident what has happened. If water soluble materials enter a waterway, it is frequently very difficult to trace these without instrumentation unless the contaminants have strong identifying odors or colors. In this area, the shippers, backed by their knowledge of the professional decontamination companies, can provide expertise to supplement that available to the U.S. Environmental Protection Agency, and other Federal and State agencies which would be called to the scene of such incidents.

The frequency with which you will encounter "chemical" spills will probably be markedly lower than for oil. A study some years ago showed that movements of gasoline alone exceeded the largest volume chemical by a factor of 20. When crude, heating, and other oils are included, it is logical to expect much less total activity in chemicals. But, as the volume decreases, the complexity of handling increases.

The chemical industry, through Chemtrec and the company resources, is working to assist in reducing the effects of transportation emergencies and spills.

III

Biological and Physical Impacts of Oil and Hazardous Substances



Moderator: Randall W. Smith

TYPES AND CHARACTERISTICS OF OILS AND HAZARDOUS CHEMICALS

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OILS

We are all reasonably familiar with the properties of oil when spilled on water. Oil is normally insoluble in water, less dense than water, and persists in the environment for some time as an identifiable material. Oils may be of mineral origin (such as crude oil), of vegetable origin (such as palm oil), or of animal origin (such as tallow). Chemically, "oils" may be composed of hundreds of various chemical compunds, which may be liquids, solids, and gases dissolved in a homogeneous liquid. Oil may be "thin" and spread rapidly over the water's surface or be "thick" and coagulate in so-called pancakes. Some oils must be heated to allow them to be pumped and when they are spilled on water, will adhere together into "tar balls" which persist for months as pieces of asphalt-like materials in the oceans. While most oils float, some oils have densities near that of water. If cold, the oil may have a density greater than that of water and sink. As the water temperature increases, the oil may become neutrally buoyant and then float. Such an appearance of an oil in the spring, after an oil spill which appeared minimal in the winter, can cause quite a bit of excitement.

Oils in transportation are classed as flammable or combustible liquids. Flammable liquids are those liquids whose vapors can be readily ignited at room temperatures. Combustible liquids are those liquids which must be heated before the vapors can be ignited. When in marine transportation in bulk quantities by tank vessel, oils are regulated by the U.S. Coast Guard, under 46 Code of Federal Regulations (CFR) 30 to 40, Subchapter D, Tank Vessels. Such tank vessels are designed primarily to prevent or reduce the possibility of ignition of the flammable or combustible vapors above the oil cargo and prevent the release of the oil to the environment. The vapors given off by oils may not only be flammable or comustible, but also may be toxic, irritating, anesthetic, or a combination thereof. Crude oils, in particular, contain many gases which can be, if not unpleasant smelling, injurious, or fatal when inhaled. "Sour" crudes contain hydrogen sulphide gas, whose toxic properties parallel those of hydrogen cyanide gas. Some oils, notably crudes and residual oils, have constituents which are skin carcinogenic and care should be exercised when handling them.

Oils are carried in single skin tank ships or tank barges. The outer hull of the vessel serves as the cargo containment system. Any breach of the hull due to grounding, collision, minor side damage, or tank overpressurization can result in a spill. The quantity of oil carried as cargo can vary from 20,000 gallons per tank in six tanks for a small barge up to 1 million gallons per tank for a supertanker.

The removal of oils from water is fairly straightforward. As previously mentioned, oils are usually visible, float, and are insoluble in water. When spilled on water, the hazardous properties of oil are diminished through "weathering," a process whereby the lighter, more volatile flammable and toxic gases and liquids, dissolved in the oil, vaporize and are borne off by the wind. Note that if burning of an oil spill is contemplated, the burning operation is best initiated as rapidly as possible to take advantage of the flammable constituents. Oils can be fairly safely boomed and slurped, lapped, skimmed, or whatever, to remove them from water. It is fairly accurate to state that a great amount of expertise and equipment has been evolved by both government and industry in removing oil from water and restoring the environment after an oil spill.

The toxicity of oil to the aquatic environment varies with the type of oil, time of year, host factor, weather, etc. Some oils are slightly soluble in water or have components which are soluble. These soluble components are usually fairly toxic to marine life. Oils also coat birds, mammals, exposed shellfish, and the like, which disables or interferes with some life function of the animal. Dense oils may sink and cover the floor of the river, harbor, or ocean. Again, this harmfully interferes with some life function of the sessile aquatic species.

Under the Federal Water Pollution Control Act (FWPCA), removal of oil can be paid for out of a "revolving fund" established by Congress for that purpose. The definition of "oil," for which monies can be expended by the revolving fund differs somewhat from that we have heretofore discussed. "Oils" for which the revolving fund can be used are those oils which are naturally produced, nonchemically distinct, persistent, and insoluble. If the oil does not meet all these tests, then it is not an "oil" for which the revolving fund can be used. This definition of oil under the FWPCA is a question of law in the nature of a judicial determination rather than an administrative determination. However, the agencies charged with the enforcement of the Act, the U.S. Coast Guard, or the U.S. Environmental Protection Agency (EPA), may make an administrative determination of oil until challenged and/or modified in a judiciary proceeding.

The term "oil" indicates a range of materials which have fairly consistent properties. These consistent properties make the identification, removal, and cleanup of an oil spill incident fairly similar from place to place. Oils are normally "forgiving" materials in the hazardous aspect sense.

Mistakes made with oil spill cleanup do not endanger populated areas and generally only result in greater dirtying of a larger area than necessary. While the environment may suffer, oil spills do not especially endanger property or people.

HAZARDOUS CHEMICALS

Spills of hazardous chemicals do, however, endanger property and people. Additionally some hazardous chemicals present a far greater risk to the aquatic environment than oil.

What are hazardous chemicals? The definition which the Coast Guard has adopted includes all those materials in marine transportation which if released could hurt people, property, and/or the environment. Note that this definition includes "oil," and this is reasonable, since oil is a chemical. Oil is considered a hazardous chemical, but will not be discussed further.

In a regulatory fashion, hazardous chemicals can be divided into four major groups, based upon how and by whom the material is regulated by an agency of the Federal Government. Unfortunately, a material can appear in all four groups. These four groups are: hazardous materials, bulk liquefied gases, bulk chemicals, and hazardous substances.

Hazardous Materials

These are "packaged" or intermodally transported materials meeting specific definitions established by the Materials Transportation Bureau in the U.S. Department of Transportation. Regulations cover hazard classes and include packaging, labeling, stowage, and the like. Quantity of the package may be from a few grams or ounces to a small package to a 40,000 gallon rail tank car. Specific regulations are found in 49 CFR 170 to 179. The major hazard classes consist of: (1) radioactive material, (2) poison material, (3) compressed gas, (4) flammables, (5) oxidizers, (6) flammable solids, (7) corrosive material, and (8) explosives.

Bulk Liquid Chemicals

These are liquid chemicals transported in a vessel's own tanks. The products are specifically listed in 46 CFR 153 for self-propelled vessels and in 46 CFR 151 for nonself-propelled barges. Quantities may range from 30,000 to 40,000 barrels and more. The U.S. Coast Guard writes and enforces these regulations.

Bulk Liquefied Gases

These are bulk quantities of liquefied gases transported in a vessel's own tanks. The products are specifically listed in 46 CFR 154 (Proposed) for self-propelled vessels and 46 CFR 151 for nonself-propelled barges.

Quantities may range up to 125,000 cubic meters. The U.S. Coast Guard writes and enforces these regulations.

Hazardous Substances

These are products which the EPA has designated as harmful to the aquatic environment. The primary selection criterion is the high toxicity to fish and an economic criterion of relatively low cost. At present, 299 chemicals have been designated as hazardous substances.

Unlike "oil," hazardous chemicals possess physical, chemical, and toxicological properties which vary greatly. Any spill must be approached on an individual basis. The product may or may not be harmful to the environment, may or may not be harmful to people or property, may or may not be persistent, may or may not be soluble, may or may not float, etc. In many cases, a spill may not be recoverable and there is little or nothing that can be done.

SOME CONSIDERATIONS FOR EMERGENCY RESPONSE

In an incident involving a hazardous chemical, the single, most important piece of information is obviously the identification of the spilled material. Without knowing the identity of the specific material, little or no action can be taken. No one should consider entering the area of the spill without a complete set of protective clothing prior to identification of the material. A complete set of protective clothing consists of complete contact protection and full respiratory protection from a positive pressure breathing apparatus. Once the material has been identified, a lesser type of protective clothing may be authorized. Also, anyone who dons protective equipment should be quite familiar with the equipment, for he is about to enter a potentially hostile environment.

A second determination which must be rapidly made is whether the worse has happened, or "can the situation get worse?" If the situation can get worse, then personnel evacuation or whatever action is necessary to limit the hazardous exposure, must be made.

The next step to take is to decide on a course of action to mitigate or control the emergency, especially if the worse has not happened. Once a course of action is determined, then constant monitoring must be done to insure that the desired effect is being accomplished. If the desired result is not being attained, then a new course of action should be determined, set in motion, and again, monitored for the desired result.

The person in charge of the incident is the On-Scene Coordinator (OSC). His responsibility is to prevent the situation from worsening, mitigate the effects of the spill, and return the situation to normal as rapidly as possible. He works within a system of priorities or "protection factors." The order of priorities for an OSC are: (1) protection of people, (2) protection of the environment, and (3) protection of property.

The information he will need to assess the potential environmental effects will in part be provided by the Fish and Wildlife Service and its State or local counterparts. Within their realm of expertise, they should establish priorities for protection of a geographical area or particular species, or whatever, and make their determinations known to the OSC. Then, the OSC must take this information and together with all the other information he has received, establish his plan of action and protection.

During a hazardous chemicals incident, the overall hazard presented to people may far outweigh any hazard presented to the environment. In other words, environmental considerations, no matter how serious, may be of secondary importance. It must be recognized that in some instances in order to reduce a potential harmful exposure to people, a controlled release of a hazardous chemical may be made which has serious environmental effects.

INFORMATION SOURCES

When assessing the potential environmental impact of a hazardous chemical, there is a limited amount of information. The most likely information source is the chemical manufacturer. Of late, the U.S. Coast Guard has found that the chemical manufacturers have been quite willing to share information, recommend procedures, and assist in establishing courses of action. Other sources of information include the Coast Guard's Chemical Hazard Response Information System (CHRIS) and the EPA's Office of Hazardous Materials - Technical Assistance Data System (OHMTADS). OHMTADS is especially helpful in obtaining information on hazards to aquatic animals. Other information sources include the U.S. Coast Guard's National Response Center and Chemtrec.

METHODS USED AT PATUXENT WILDLIFE RESEARCH CENTER TO STUDY THE EFFECTS OF OIL ON BIRDS

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INTRODUCTION

The obvious damage to the flora and fauna following an oil spill receives a considerable amount of attention. News media accounts are usually replete with photographic evidence of the disastrous effects of these catastrophes. Although the numbers of dead and oiled animals found at the scene of a spill are somtimes large, the effect on wildlife from the low levels of oil remaining after cleanup procedures or from continuous low-level contamination in other areas may be equally damaging. However, these low-level exposures are difficult to detect. An understanding of their ecological impact requires scientific attention. Chronic low-level effects of oil on the environment are being investigated by a number of research groups. The Patuxent Wildlife Research Center has focused its oil contamination research on birds. Members of the research group include wildlife biologists, physiologists, and chemists. The purpose of this paper is to present the experimental approaches used by researchers at the Patuxent Center to resolve some of the questions concerning the effects of chronic low levels of oil on birds.

METHODS AND RESULTS

Oil can be ingested by birds directly while drinking or feeding, ingested indirectly via the food chain, or applied to incubating eggs by the adult. The effects of oil on avian species through these routes of exposure were determined in three types of related experiments: 1) indoor pen studies, 2) incubator studies, and 3) outdoor field studies. To assess the effects of oil ingestion on birds, investigators monitored several parameters, including mortality, growth (weight gain and wing measurements), plasma enzymes, and liver function. Several routine clinical biochemical techniques for assessing damage to mammalian systems were adapted for birds. Thus, measurements were made on plasma enzymes that reflect damage to specific organs such as kidney, liver, and heart. In addition, a technique established for mammals to directly indicate a change in hepatic function was found acceptable for avian species (Patton 1978). Organ damage measured biochemically was confirmed at both the macroscopic and microscopic level by a pathologist

(Szaro et al. 1978; Patton and Dieter, in press; Coon and Dieter, in preparation; Szaro, in preparation). In several studies, tissues from dosed and undosed ducks were chemically analyzed for oil components.

Indoor Pen Studies

Studies in indoor pens are advantageous because light, temperature, water, food intake, and other external elements can be precisely controlled. Under constant conditions, the effects on test animals of varying one or more factors at a time can be examined.

Feeding studies were conducted to determine the effects on birds of ingesting different doses of crude oil in their food. In initial studies with adult mallard ducks *(Anas platyrhynchos)*, various amounts of crude oil were included in commercial duck feed. Briefly, pairs of mallards were placed in separate cages and fed either clean feed or one of the several diets containing crude oil at environmentally realistic values ranging from 0.25 to 2.5%, for 26 weeks. Those receiving oil in their diet laid fewer eggs than did controls (Coon and Dieter, in preparation). In another experiment, adult mallards compensated for oil ingestion with an increased liver clearance capacity (Patton and Dieter, in press).

Subsequent experiments have been conducted, in which ducklings were fed test diets containing 0.025 to 5% oil from the day of hatching (Szaro 1978; Szaro, in preparation). After studying the effects of several crude oils, an experiment was done to examine the effects of various components of these crude oils (Patton and Dieter, in press). Crude oils, ingested with food, have retarded growth, increased liver size, increased plasma enzyme activities of alanine aminotransferase and ornithine carbamyl transferase (indicative of liver and kidney damage), and decreased spleen size and hematocrit in ducklings (Szaro et al. 1978; Szaro, in preparation).

Chemical analyses of these ducks showed that ingested oil components had been absorbed and could be found accumulated to a greater extent in fat than in liver, kidney, and several other tissues (Lawler et al. 1978; Lawler, Loong, and Laseter, 1978a, 1978b).

Indirect ingestion of oil may occur through the food chain. This hypothesis was tested using a radioactive isotope. Previous studies had strongly implicated the aromatic hydrocarbon fraction of crude and No. 2 fuel (diesel fuel) oils as being most toxic. When crude oil is mixed with water, these aromatic fractions are found in the water-soluble fraction (WSF). A volume of No. 2 fuel oil was poured onto water (5% oil by volume) to simulate an oil spill. This mixture was stirred for 20 hours. No. 2 fuel oil contains approximately 16% napthalenes and about 40% total aromatics. The aqueous phase containing the WSF was decanted, and a known activity of ^{14}C-naphthalene was added. Crayfish were placed in the WSF for 3 hours and then fed to adult ducks. The WSF, the crayfish, and the duck tissues were measured for radioactivity. Knowledge of the activity of ^{14}C-naphthalene that was added and the amount of aromatics or naphthalene in the WSF allowed calculation of the amount of contaminant in each phase of the experiment (Tarshis, in preparation). The results from these experiments have supported the hypothesis that transfer of aromatics through a simple aquatic food chain is another route for oil contamination to reach waterfowl.

Taken together, the results from the studies described suggest that, to a degree, adult ducks ingesting oil with their food may be able to make physiological compensations. There may be damage to organ systems, however, that directly affects the ability of the bird (especially the young) to survive a second environmental challenge (Holmes, Gorsline, and Cronshaw 1979). There is also some evidence that oil ingestion by adults affects egglaying (Holmes, Cavanaugh, and Cronshaw 1978; Coon and Dieter, in preparation). Studies are underway at the Patuxent Center to further define this reproductive effect.

Incubator Studies

Incubators were used as an aid to study the effects of microliter (μl) quantities of crude and No. 2 fuel oils on developing avian embryos. A technique was developed in which oil was externally applied in precise amounts (ranging from 1 to 50 μl) to discrete areas of bird eggs (Szaro and Albers 1977, Albers 1977, 1978). The eggs were subsequently placed in an incubator maintained at optimum temperature and humidity. Eggs were routinely candled to monitor mortality and embryo development. Surviving embryos were examined at 18 days of age or permitted to hatch. External applications of oil were found to increase mortality and incidence of defects and stunting in mallard embryos (Eastin and Hoffman 1978; Hoffman 1978a, 1978b, Hoffman 1979a). In addition, a dose:mortality relationship was shown. Eggs from other species were collected from coastal areas and brought back to the laboratory (Szaro and Albers 1977, Coon et al. 1979, White et al. 1979). When these eggs were dosed with oil, as in the previous studies, the mortality was not as great. One major difference between the two studies was that the mallard eggs were synchronous in development, whereas field-collected eggs were at various stages of embryo development. Laboratory studies were performed to investigate the possibility that there is a differential sensitivity to external oiling during development. The results were clearcut and indicated high mortality at two distinct periods early in the development, but that egg oiling after this critical time had little effect.

It also was decided to examine in detail certain suspect trace metals and those components chemically identified in the aromatic hydrocarbon fraction of crude oil to try to further understand the toxicity to embryos. The porphyrin forms of vanadium and nickel found in crude oil are much less toxic to embryos than are some of the salts previously tested on birds and mammals. These porphyrin forms did, however, produce some defects in embryos (Hoffman 1979b). And mercury, if present in sufficient quantity, was toxic (Hoffman and Moore 1979a, 1979b). Of the aromatic fraction components, the polycyclic aromatics including chrysene, benzo(a)-pyrene, and dimethylbenzanthracene produced high mortality in embryos (Hoffman 1979a, Hoffman and Gay, in preparation). The incubation experiments just described have helped elucidate the effects that minute amounts of oil would have during the reproductive season.

Outdoor and Field Studies

The indoor pen studies have been invaluable, because under optimally controlled environmental conditions they provided indicators of the subtle types of chronic effects oil may have in natural bird populations. It is highly essential, however, to show correlative effects of crude oil contamination occurring under normal field conditions. Therefore, studies were conducted to confirm effects of oil on birds under more realistic environmental conditions. Outdoor pens were used to determine whether oil applied to small pools of water used by mallards for drinking and swimming would be carried on the ducks' breast feathers to the nest. Eggs of these ducks became oiled, and mortality to the embryos was comparable to those incubated artifically (Albers, in preparation). Additional oil-related studies have been done in the field with a variety of birds. Most of this work was and continues to be done by Fish and Wildlife Service personnel and to a lesser extent under cooperative agreements with State universities. The effects of No. 2 fuel oil on hatchability of marine and estuarine bird eggs naturally incubated in the field were compared with its effects on eggs artifically incubated. Eggs of three species of birds from breeding colonies on the Texas coast were randomly selected, 20 μl of No. 2 fuel oil was applied to the eggshell surface, and the eggs were returned to the nest. After 5 days of natural incubation, embryo mortality was determined. No. 2 fuel oil produced 56% or greater mortality in this study, only slightly less than that in eggs artificially incubated (White, King, and Coon 1979). In other field studies, nesting marine birds were trapped, oil was applied to their breast feathers, and the birds were released. After some preening and swimming, these birds returned to their nests and continued incubating their eggs. Again, embryo mortality was similar to that in the incubator studies (King and Lefever, in preparation). These studies under natural conditions indicated that birds with oiled breast feathers return to their nests and contaminate the eggs they incubate. Literature reports and personal communications with biologists responding to oil spills include accounts of birds foraging in oil-contaminated areas and collecting oil on their breast feathers. Although not as well documented, bird nests containing oiled eggs also have been observed after oil spills occurred near breeding areas (Alexander et al. 1978). These kinds of observations need further documentation to assess the frequency of their occurrence.

SUMMARY

The results from the laboratory studies done at the Patuxent Center have shown the developmental stages to be extremely susceptible to the effects of low-level oil contamination. Although adult ducks may be able to physiologically compensate for oil in the diet, evidence suggests a lowered tolerance to a second environmental challenge. There is also some evidence that chronic ingestion of small amounts of oil by adult female ducks affects reproduction. These secondary effects are not clear and require more study before their importance to the survival of avian populations can be fully understood. In addition to the experimental results, several reliable indicators have been established to assess the sublethal effects of crude and No. 2 fuel oils on all stages of the avian life cycle. More importantly, insight has been gained into the detection and measurement of the effects of crude oil on natural bird populations.

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OIL DISPERSANTS AND WILDLIFE

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Chemical oil dispersants are used routinely throughout the world. The most notable exception is in the United States which has discouraged their use. The improper use of large amounts of highly toxic dispersants at the wreck of the *Torrey Canyon* in 1968 (Smith 1968) was largely responsible for this cautious attitude toward oil dispersants. Field testing of chemical dispersants in the territorial waters of the United States began in September 1978, with tests off the coast of southern California sponsored by the American Petroleum Institute and the Southern California Petroleum Contingency Organization (Smith and Holliday 1979). The tests were designed to evaluate dispersant effectiveness, application procedures, and effects of chemically dispersed oil on marine organisms. The U.S. Environmental Protection Agency (EPA) has approved several dispersants for use in the United States when necessary. This approval means that oil spill response coordinators may be confronted with an increasing number of proposals to use chemicals to disperse oil.

GENERAL INFORMATION

Oil dispersants are manufactured by many chemical companies and marketed under trade names that do not describe the chemical composition or the appropriate uses (open sea, beach, method of application). The manufacturer may make specific recommendations about application methods, but information about effectiveness should be obtained from testing laboratories such as the Warren Springs Laboratory in England or regulatory agencies such as the EPA. Oil dispersants are referred to as either "conventional" or "concentrated." The conventional type consists of a surfactant, hydrocarbon solvent, and a chemical stabilizer. New conventional dispersants have less aromatic hydrocarbons in the solvent and the surfactant is more biodegradeable than the older types (Swedmark et al. 1973). Concentrated dispersants are a mixture of several surfactants and small amounts (5 to 10 percent) of additives which serve to stabilize the surfactant mixture, inhibit rust, etc. (Margaret Walsh, personal communication).

Oil dispersants can be applied from aircraft, boats, or by the use of portable sprayers. Conventional dispersants and some concentrated dispersants require mixing after the dispersant is sprayed on the oil slick. This is usually accomplished by a boat, by objects tethered behind a boat, or by high pressure water spray. Concentrated dispersants classified as "self-mixing" (e.g., Exxon Corexit 9527) require no additional mixing. Self-mixing dispersants supposedly break oil into fairly homogeneous particles $\leq$ 1 micron in diameter which have a rise velocity of zero (Canevari 1975). Dispersants that are not self-mixing produce oil particles that are heterogeneous and vary in size from 10 microns to several millimeters. These particles will return to the water surface unless there is considerable wave action.

ADVANTAGES AND DISADVANTAGES OF DISPERSANTS

Research on dispersant effectiveness and on the biological effects of dispersed oil has been limited. Most of the information available comes from laboratory experiments which are often difficult to relate to field conditions. Although statements of advantages and disadvantages of using chemical oil dispersants are based on conclusions derived from inadequate information (Exxon Production Research Company 1978), it is appropriate to present the most commonly reported characteristics of dispersant use.

The advantages of using dispersants to control oil spills include:

1) Dispersants remove oil from the water surface by dispersing the oil into the water column. This eliminates the fire hazard, air pollution from volatilization, and the threat of serious oiling for water birds; and accomplishes the cosmetic improvement of removing the oil from sight.

2) The dispersion of oil prevents the formation of water-in-oil emulsions ("chocolate mousse") and tar balls. Water-in-oil emulsions are particularly difficult to deal with because the emulsified water causes an increase in the volume of oily material that must be removed from shorelines and the emulsions do not respond well to dispersants (Canevari 1975).

3) Dispersed oil will not adhere as well to shorelines, plants, and animals as will nondispersed oil. Dispersal, therefore, is an important consideration when oil is expected to reach intertidal areas, beaches, islands, or large concentrations of birds.

4) Dispersants increase the surface area of the spilled oil, permitting more rapid weathering and biological deterioration (Wells and Keizer 1975).

The disadvantages of using dispersants to control oil spills include:

1) Oil dispersants cause the concentration of oil in the water column to increase rapidly, with a corresponding increase in toxicity. The increase is temporary, but species not affected by the floating oil may be affected by the dispersed oil (Swedmark et al. 1973), Wells and Keizer 1975, Linden 1976, Dalla Venezia and Fossato 1977, Trudel 1978), thus increasing the short-term

biological impact in intertidal areas, shallow estuaries, and wetlands.

2) Dispersant-treated oil may penetrate deeper into sand and gravel on beaches and cause more oil to be lodged below the beach surface than would occur with untreated oil (Hayes and Gundlach 1978).

3) Dispersants may not work as well as expected. Experiments have shown that more dispersant is usually needed to satisfactorily disperse the oil than the manufacturers suggest (Swedmark et al. 1973, Linden 1975, Wells and Keizer 1975, Gill 1977, Dalla Venezia and Fossato 1977, Smith and Holliday 1979). This reduced effectiveness may be caused by bad weather, application problems, inappropriate use of the dispersant, insufficient water turbulence to keep oil particles from rising, or overly optimistic estimates of dispersant effectiveness by the manufacturer.

4) The use of chemical dispersants is basically unappealing to wildlife biologists. Dealing with environmental contamination by a toxic substance whose biological effects are only partially understood is difficult. To deal with such a contaminant by applying large amounts of another toxic substance whose effects are also only partially understood may appear to be a risky venture.

It is clear that decisions on the use of dispersants should be made carefully on a case-by-case basis.

EFFECTS OF OIL DISPERSANTS ON BIRDS

Little was known about the effects of oil dispersants or chemically dispersed oil on birds until experiments were initiated at the Patuxent Wildlife Research Center in 1978. I will briefly present the results of a recently completed study of the effects of Corexit 9527 dispersant and oil/Corexit 9527 mixtures on egg hatchability. I also will describe two other studies that are in progress. The egg hatchability study will be reported in detail elsewhere (Albers, in preparation).

In the egg hatchability study, artifically incubated eggs of the domestic mallard (*Anas platyrhynchos*) were treated on the sixth day of incubation with 1, 5, or 20 microliters (μl) of Prudhoe Bay (Alaska) crude oil, Corexit 9527, a 5:1 oil/Corexit 9527 mixture, or a 30:1 oil/Corexit 9527 mixture. All were applied to the surface of the egg with a microliter syringe. Nothing was applied to the control eggs. All four substances caused a significant ($P \leq 0.01$) reduction in egg hatchability at the 20 μl level. Corexit 9527 and the 5:1 oil/Corexit 9527 mixture also caused a significant reduction in egg hatchability at the 5 μl level. The 5:1 oil/Corexit 9527 mixture caused the death of embryos earlier than did the Corexit 9527 and the 30:1

oil/Corexit mixture. These results indicate that: (1) Corexit 9527 is at least as toxic to bird embryos as Prudhoe Bay crude oil, and (2) oil/Corexit 9527 mixtures are toxic to bird embryos but the degree of toxicity probably depends on the mixing ratio. However, it is not known whether oil/dispersant mixtures in the form of minute particles dispersed in water can be transferred to bird eggs or whether these dispersed particles pose any threat to adult birds.

One of the two ongoing dispersant studies deals with the transferability of chemically dispersed oil to bird eggs and the effects of dispersant and chemically dispersed oil on bird breeding behavior. Breeding pairs of mallard ducks are being exposed to Corexit 9527, Prudhoe Bay crude oil, a 10:1 crude oil/Corexit mixture, or no contaminant. The test substances are applied to the surface of water in water troughs located in each pen. The substances are applied during the first week of incubation, remain on the water for 2 days, and then are removed for the remainder of the incubation period. Nests from each experimental group are being monitored for nest and egg temperatures as an indirect measure of incubation behavior.

The other ongoing dispersant study concerns the effects of chronic ingestion of dispersants and crude oil/dispersant mixtures. Mallard ducklings are being fed duck starter mash containing either 1.5 percent Prudhoe Bay crude oil, 1.5 percent of a 10:1 water/Corexit 9527 mixture, 1.5 percent of a 10:1 crude oil/Corexit mixture, or no contaminant. The ducklings will be fed these diets from hatching until they are 18 weeks old. All birds then will be placed on clean feed through the end of their first breeding season. Information will be gathered to evaluate mortality, growth and development, liver and kidney damage, dehydration, hormonal profile, and egg production.

SUMMARY

Chemical oil dispersants currently are being evaluated as a method of oil spill control in the United States. Dispersants remove oil from the water surface, prevent the formation of water-in-oil emulsions, reduce the ability of oil to adhere to objects, and permit accelerated deterioration of the oil. However, chemically dispersed oil also has a greater short-term toxicity and a greater ability to penetrate sand and gravel beaches than does nondispersed oil. In addition, chemical dispersants seldom work as well as expected and, from a biologists's viewpoint, they are an undesirable method of oil spill control. Decisions on the use of dispersants should be made carefully on a case by case basis.

Corexit 9527 was found to be at least as toxic to mallard embryos as Prudhoe Bay crude oil. The toxic effects of crude oil/Corexit 9527 mixtures appear to increase as the amount of dispersant increases. Studies are underway to examine the transferability of chemically dispersed oil to bird eggs, the effects of dispersant and chemically dispersed oil on bird breeding behavior, and the effects of ingested dispersant and crude oil/dispersant mixtures on avian physiology.

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HAZARDOUS SUBSTANCES: A THREAT TO AQUATIC RESOURCES

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The age of chemistry has introduced a multitude of chemical contaminants, many of which are incompatible with man's environment and threaten the welfare of living resources everywhere. Identification of some of the insidious effects that result from chronic exposure of biota to these chemicals is only beginning. Considerable efforts are being made to evaluate the effects of chemicals that are already being used and disposed of. However, the evaluation of future hazards to fish and wildlife resources must be improved. Such an effort necessarily requires a multidisciplinary approach that emphasizes the anticipation of contaminant threats of the future. Researchers, resource managers, and other decisionmakers in industry and government will have to participate closely in sharing information and assessing the impacts of contaminants on living resources. Only in this way can the present reactionary posture in addressing the pollution problems of the future be avoided.

More than 87,000 chemicals now produced in the United States are possible environmental contaminants. The U.S. Environmental Protection Agency (EPA) has listed 129 toxic substances for immediate hazard assessment related to production, distribution, use, disposal, and persistence in the environment. Data on toxicity, environmental fate, degradation, ecological impact, and human health must be assimilated for a full and meaningful hazard assessment of many of these toxic substances. Many more chemicals await intensive study to determine their potential impact in the environment. The chemical complexity of hazardous substances ranges from simple discrete compounds such as DDT to highly complex multicomponent mixtures. The polychlorinated biphenyls (PCB's) and the insecticide toxaphene each include more than 100 isomers of varying degrees of toxicity and persistence (Zell et al. 1978, Jansson et al. 1979). Oil and coal, which contaminate the environment by spills, natural seepage, combustion, and careless disposal, are even more complex. They contain numerous organic compounds, metals, and organometallic complexes. The complexity of such contaminants is staggering, and is further complicated by the differences in the chemical composition of coal and oil from one location to another.

SETTING RESOURCE PRIORITIES

The potential for study and hazard assessment of this multitude of new-generation contaminants is overwhelming. Many contaminants cannot be analyzed or identified in biological matrices by using existing technology. It is difficult to formulate realistic hazard assessments without knowing a chemical's environmental concentrations and biological availability. From thousands of candidate contaminants about which little is known, those chemicals most likely to pose the greatest danger to our environment must be carefully selected for detailed research. More specifically, as the agency charged with the stewardship of the nation's living resources, the Fish and Wildlife Service must employ rational guidelines to assist in determining research priorities for contaminants that are threats to wildlife and fishery resources of greatest value. A research approach has to be developed that ensures primary consideration of the most vulnerable, priority resources that may be affected by contaminants. Limited funds and manpower dictate the necessity of identifying critical biota and habitat of highest priority, and of orienting research toward the assessment of real or potential impacts of known or candidate contaminants most likely to impinge upon these resources. This orientation can be carried out most effectively if experts in contaminants research and resources managers work together to identify problems and formulate research policies and design. Once priority resources have been identified, the task of selecting for study and assessment the contaminants of greatest concern becomes simpler.

RESEARCH APPROACH TO CONTAMINANT PROBLEMS

Environmental contaminants may be divided roughly into two categories for consideration. The first category includes the general collection of contaminants that are known to exist in wildlife or fisheries today -- such as DDT, DDE, toxaphene, PCB's, and mercury, or anything that has been chemically identified and confirmed, even though the complete biological significance is not yet clearly defined. The second category is less clear and includes suspected or potential contaminants that have not yet been identified, or whose detrimental effects have not been proven. This group might include new pesticides, unstudied industrial chemicals, some energy-related contaminants, or even some well-known contaminants for which new or broader uses have been developed.

Major research efforts to date have necessarily focused on identified contaminants known or suspected of causing environmental problems. Little effort has been made to conduct anticipatory research on contaminants associated with new products, energy development, changing land uses, etc. and intermediate and degradation products of chemical processes have received little attention. The reasons for this historical research emphasis are many and complex, but the following five are perhaps primary: (1) there is no foolproof, clearcut way to determine exactly what contaminants of the future will be; (2) selections of contaminants for early research are based on scientific likelihood and intuition, and are therefore risky; (3) appropriate research may be difficult to design; (4) public and even scientific concerns are usually minimal until a contaminant becomes an environmental problem; and (5) implementation of anticipatory research may be difficult to justify because of a lack of documentary data. In addition, the prevention or minimization of a future contaminant problem is seldom as widely heralded as is the recognition of a present environmental problem and the research findings on its effects.

At the Columbia National Fisheries Research Laboratory (CNFRL), we believe it is important to consider the effects of known contaminants and to identify new contaminants, as well as to predict and evaluate possible future contaminants. If no effort is made to initiate and develop an anticipatory approach, research efforts will always be in a reactive posture. However, anticipatory research and reactive research are not mutually exclusive; they must go on concurrently and interactively.

In general, we view anticipatory research on contaminants as a mixture of analytical chemistry, toxicology, biological evaluation, and communication. Sophisticated analytical techniques are important for the detection and identification of existing, but unrecognized contaminants. In addition, they should undergo some preliminary toxicological evaluation. Laboratory toxicologic assessments of contaminant effects on aquatic organisms under simulated conditions (e.g., use or exposure pattern, appropriate species, temperature, water type) are important for projections of potential effects on fisheries. As previously unknown contaminants are detected and identified in aquatic ecosystems, they should be surveyed to estimate the degree, source, and extent of contamination. Communication is essential to link current research with information sources in assessing new inputs of potential contaminants to various ecosystems and for disseminating research findings to resource managers and other decisionmakers. Beyond this point it is extremely difficult to predict the most effective courses of research action. However, field ecological approaches ranging from small, local studies to large, system investigations might be appropriate and could probably be linked with monitoring efforts or other analytical or biological surveys. Objectives of such studies likewise cover a broad range, including discovery, documentation or correlation of contaminant effects on aquatic populations; distribution of the contaminant; and investigation of its dynamics in the ecosystem.

For better known contaminants, primary efforts are probably best directed toward field investigations that can then be supported by interdisciplinary laboratory investigations to assist in interpretation of field data. Assessments of fishery stocks and various forage bases are important elements to be maintained on a continuing basis. Such assessments are a form of biomonitoring to estimate trends in the general condition of the fishery.

BIOLOGICAL INDICATORS OF CONTAMINANT STRESS

At CNFRL we are necessarily placing increasing emphasis on the use of biological and biochemical techniques as indicators of health and the well-being of aquatic populations and habitat. Shifting our attention to the resource as the focal point to determine the likelihood and extent of a contaminant perturbance relieves us of total dependence on the analytical chemistry approach. With even the most advanced analytical technology, only a small fraction of the chemicals known to exist in the environment can be identified and quantitated -- and the cost is high. The detection of any given contaminant in the tissues of a species only proves that the chemical is present. The biological significance of the contaminant or contaminants in question must be determined by studying the organism and evaluating its ability to function.

Though much progress has been made in developing biological indicator techniques, only the surface has been scratched. This is a very promising and exciting field of contaminant research but it may often be high risk and time consuming. Nevertheless, the progress that has been made in "bioindicator" research leads to the conclusion that it affords too great an opportunity for the future to be neglected. Several bioindicator techniques that show considerable promise are being tested or successfully used by fishery and wildlife biologists and toxicologists (Mehrle and Mayer 1979).

Bioindicator techniques are essentially used for two purposes. The first is to monitor for the presence of contaminants, particularly when an attempt is being made to locate point-source pollution such as may occur from an industrial effluent. Mobile units can be used to draw water from suspected pollution source and expose test species for measurement of physiological responses. Opercular rates (Sparks et al. 1972) and cough rates (Drummond and Carlson 1977) have been used to monitor for the presence of contaminants in industrial effluents. The second purpose, more meaningful from a population viewpoint, is to measure biological or biochemical characterisitics that reflect whole-animal responses related to essential life processes (survival, growth and development, reproduction, and adaptability) of the organism or organisms in question (Mehrle and Mayer 1979). Eggshell thickness, for example, has proved to be an excellent bioindicator related to reproductive success in avian species subjected to high exposures of DDE (Klaas et al. 1974). Likewise, collagen composition in connective tissues, particularly in the vertebrae, is a good indicator of inhibition of growth and development in fishes exposed to contaminants (Mehrle and Mayer 1975). Other indices such as behavioral patterns, biochemical imbalances, and incidences of teratogenesis or carcinogenesis may prove to be useful indicators of contaminant impacts on wildlife populations. However, much research will be necessary to test the usefulness and applicability of these approaches.

SOME RESEARCH NEEDS

Though many contaminant problems exist and many more are candidates for future concern, scientists are limited in time, manpower, and financial resources in their abilities to address them. A "shopping list" of contaminant problems that are most likely to become serious threats to valued resources can be formulated through communication with State and Federal resource managers, regulatory agencies, industry, conservation groups, and research scientists from government, academia, and industry. Some problems of considerable concern have already been identified and should be addressed.

Land use changes and the destruction of riparian habitat are having immense primary and secondary impacts detrimental to wildlife and fisheries throughout much of the United States. Grazing, agricultural clearing, and forestry practices are creating immediate losses of prime habitat for wildlife. Valuable aquatic resources are then secondarily threatened or lost as a result of increased sedimentation, often accompanied by numerous contaminants that pollute lakes and streams.

Extensive activities related to development and consumption of energy sources have a high potential for detrimental impacts on fish and wildlife resources. Toxic substances occurring in oil and coal include phenols, cresols, water-soluble aromatics (e.g., carcinogenic polynuclear aromatic hydrocarbons), inorganics, and a new generation of organometallics about which little is known. Possible contaminants arising from energy development, transport, use, and disposal are so numerous that it is difficult to know where to begin in assessing problems and projecting research needs.

Drilling and production of oil wells results in the use of large volumes of contaminated water that must be disposed of. This wastewater may carry dissolved aromatics or high levels of salts. Discharge waters in Wyoming have allowable concentration of "oil and grease" of 10 mg per liter. Fin erosion and 20 percent reduction in growth of trout was demonstrated at 100 ug per liter -- a 100-fold dilution of the maximum allowable concentration (personal communication, Dan Woodward, CNFRL-Jackson, Wyoming Field Laboratory). Personnel at the Jackson Field Station have also found that trout are attracted to oil concentrations in water that cause reduced growth and survival.

Combustion of fossil fuels is polluting precipitation with strong acids, trace elements, and complex organic contaminants (Gorham 1976). Some 450 organic contaminants, including PCB's, DDT, various polycyclic aromatic hydrocarbons, and others, have been detected in precipitation. Prevailing weather patterns are such that the northeastern U.S. is subject to extensive fallout of acids and metals in precipitation. Trace elements are higher in precipitation in the Northeast than in the Midwest or the West. There is currently a lack of information on the water chemistry and fish populations of susceptible, low buffered lakes and headwaters in New England. Surveys of selected lakes indicate that fish populations are virtually absent in waters having a pH lower than 5.5. Lowland lakes are decreasing in buffering capacity, and small headwater streams may be adversely affected particularly during spring melts.

Other present and future contaminant threats of national and regional concern are becoming more apparent to resource managers and researchers. Water loss and contamination of irrigation return flows by agricultural chemicals are creating serious problems for valued fisheries in western states. PCB's and PCB replacements will continue to be a contaminant stress on fresh-water fisheries, as will the increasing numbers of accidental spills of hazardous substances along our coasts and in inland lakes and waterways.

Use of recycled petroleum products to control road dust is a potential hazard to vulnerable nursery areas of anadromous fishes in the Pacific Northwest. Long-term cumulative effects of stack emissions from coal-fired power plants are difficult to predict and may present unanticipated contaminant stresses.

Research must continue to emphasize the study of basic principles that regulate individual, population, and ecosystem life processes, while paying more attention to the practical aspects of actual contaminant challenges to those processes. It is necessary to understand how changes in basic variables (e.g., growth, reproduction, and mortality rates) affect populations and communities before laboratory toxicological studies can realistically be related to the contaminant impacts in the environment. A multidisciplinary approach, with close cooperation among Federal, State, and private scientists and resource managers, will be necessary to meet the formidable environmental challenges of the present and the future.

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RESOURCES SENSITIVE TO OIL SPILLS (CASE STUDY OF THE SANTA BARBARA CHANNEL)

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ABSTRACT

Oil spills should be treated as ecological, not just esthetic problems. The primary goal of spill response should be to minimize the ecological impacts of oil spills, not merely to remove visible oil. Biologically sensitive areas can be identified and strategies developed to protect them in the event of a spill. Guidelines for minimum impact oil spill cleanup can be developed for various coastal habitats. These spill response planning concepts have been successfully implemented by an oil cleanup cooperative in Santa Barbara, California.

INTRODUCTION

Torrey Canyon in 1967 and Santa Barbara in 1969 were marker events. They triggered the environmental movement in both the United States and the United Kingdom and made it clear that neither government agencies or industry was prepared to deal effectively with large oil spills. Garnett (1978) states that large spills will always overtax the ability to respond. This points up the need for clear goals and priorities in response planning. Conflicts arise when spills are viewed differently by responding agencies. For example, both *Torrey Canyon* and Santa Barbara were viewed by authorities as esthetic problems rather than ecological ones. Hence, spill cleanup included methods like steam cleaning and bulldozing to remove visible oil and (in the case of *Torrey Canyon*) use of toxic detergents. Little thought was given to the ecological consequences of these severe "cleanup" methods. Unfortunately, during the more recent *Amoco Cadiz* spill, some of these same methods were still being used. What have we learned in the 12 years since *Torrey Canyon*? What should oil spill response, including cleanup, accomplish?

I propose that except where life and limb are threatened, the primary goal of spill response should be to minimize the ecological impacts of oil spills. Although spilled oil is ugly, our primary response goal should not be esthetic, i.e., to remove visible oil or present esthetic impact. There may be times and places when the esthetic goal of removing visible oil will predominate over the ecological goal of minimizing impact (e.g., during clean-up of public amenity beaches), but in the main the goal of minimizing impact should take precedence when the two conflict. For example, if a choice must be made between booming a marina full of expensive boats or booming the entrance of a salt marsh to keep oil out, the salt marsh should be boomed. Under the best of circumstances, both could be boomed, of course; but ecological impacts tend to be both longer lasting and harder to repair than esthetic impacts. We have the technology to clean oil from boats; we have no technology to clean a salt marsh without causing ecological damage in addition to that already caused by the spill.

Often, those areas most vulnerable to ecological impacts of oil spills, like salt marshes, are often the most difficult to "clean" or "restore" (Lindstedt-Siva 1979). Therefore, in terms of immediate spill response, high priority should be given to protection of biologically sensitive areas. Keeping oil away from a sensitive area is the ideal solution, because it prevents impacts from both oil and subsequent cleanup. If oil does contaminate shorelines, cleanup decisions must then be made. Methods can be chosen for specific environments on the basis of their ecological effects combined with those of the spilled oil. Low-impact techniques should be selected over high-impact methods and the "no cleanup" option should always be considered.

As coastal environments vary both physically and biologically, response to spills in these areas must vary as well. Many response decisions can be made before a spill occurs, rather than hastily during a crisis. Clean Seas, Inc., an oil cleanup cooperative based in Santa Barbara, has implemented the goal-oriented spill response planning described here. Since put into practice, it has already proven effective.

PLANNING SPILL RESPONSE TO MINIMIZE ECOLOGICAL IMPACT: THE SANTA BARBARA CHANNEL

A two-pronged planning approach was used: (1) identification of biologically sensitive areas and development of strategies to protect them, and (2) development of guidelines for minimum-impact oil spill cleanup for all types of environments in the Santa Barbara Channel.

Biologically Sensitive Areas

Ecological impacts of oil spills can be minimized if those areas most vulnerable to such impact could be protected during a spill event. Such biologically sensitive areas can be identified for a particular coastline before a spill occurs. Often, strategies can be developed to protect identified areas. Protection serves the dual purpose of preventing initial impacts from spilled oil and subsequent impacts from cleanup.

The Santa Barbara Channel (Figure 1) has had a long history of offshore and onshore oil development. It is also an area of ecological richness. It is a zone of transition between northern and southern plant and animal assemblages. The Channel Islands are major haul-out and/or rookery beaches for six pinniped species. These islands are nesting and feeding areas for many bird species. Several plant and animal species associated with the islands are endemic. Because they are less disturbed than coastal beaches, island intertidal communities are among the richest in California. The mainland supports important coastal wetlands which are vital links for migrating birds on the Pacific Flyway.

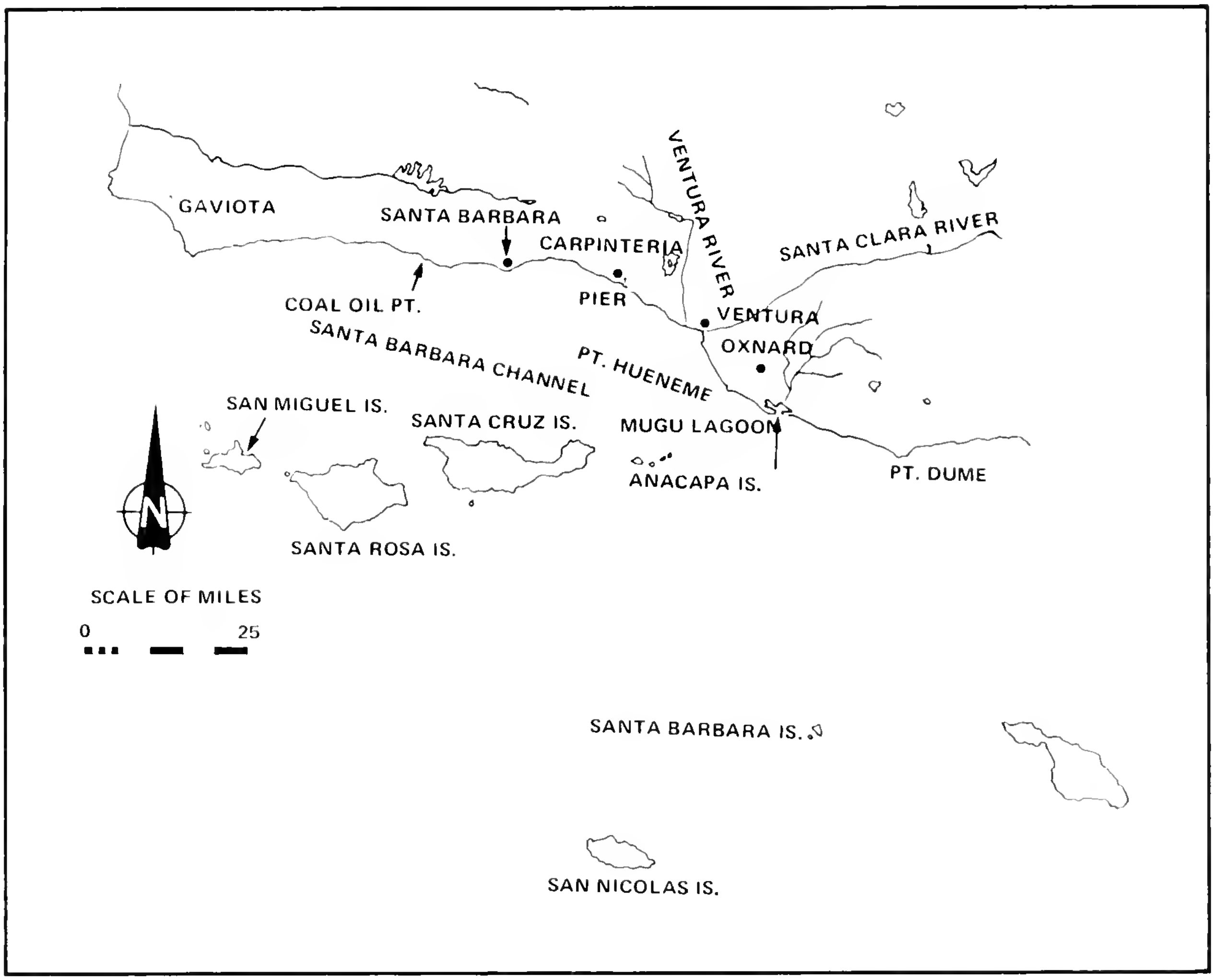

Figure 1. The Santa Barbara Channel.

Sites were identified as biologically sensitive if they have one or more of the following characteristics (Lindstedt-Siva 1977): high biological productivity, high ecological importance (e.g., feeding area, spawning/nursery area), unique features or uses (e.g., endangered species habitats), or high vulnerability to oil spill impact. Examples of biologically sensitive areas identified in the Santa Barbara Channel include island sea bird rookeries, pinniped rookeries and haul-out sites, coastal wetlands, and rich rocky intertidal communities.

Sea bird and pinniped rookeries on the Channel Islands. Sea birds nest and roost on the Channel Islands and feed in near shore waters. Certainly, the risk is high that birds would become contaminated if oil entered near shore waters. Although improvements have been made in bird cleaning and rehabilitation techniques (International Bird Rescue Research Center 1978), survival rates of oiled birds are still very low.

The Channel Islands are also used by several pinniped species as haul-out areas or rookeries. San Miguel Island (Figure 1), the western-most island and closest one to the cool California current, is used as a haul-out area by six pinniped species, five of those species breed there. For two of them (Steller's sea lion, northern fur seal) San Miguel Island represents the southern-most extension of the breeding range.

The effects of oil on pinnipeds are incompletely known. Mortalities of elephant seal pups oiled during the 1969 Santa Barbara spill were no greater than for unoiled pups (LeBoeuf 1971). Experimental work with ringed seals showed that exposure to oil caused reversible eye damage in healthy animals. However, animals already showing physiological signs of stress died soon after exposure (Engelhardt et al. 1977). Animals that partially depend on their pelts for insulation (e.g., northern fur seal) could suffer from exposure (particularly in cold waters) if oil were to interfere with the insulating properties of the pelt. Some marine mammal specialists have speculated that oil effects would be most profound during the pupping season when pups not only become oil coated, but ingest oil from their contaminated mothers (LeBoeuf 1971). Recent observations in the North Sea indicate that normal oil-avoidance behavior may be suppressed during the breeding season (Cowell 1979).

Although oil effects on pinnipeds may be incompletely known, some interesting observations have been made on the effects of disturbance by humans. The National Marine Fisheries Service has conducted marine mammal tagging and capture operations on the Channel Islands. It found that animals did not reoccupy disturbed beaches for from one to several days after such disturbances (Beach 1976, personal communication). If the disturbance occurred during the breeding season while males were holding territory, the whole social structure of the herd could be changed by a single disturbance (DeLong 1975).

Clearly, the best strategy to protect sea bird and pinniped rookeries on the Channel Islands is to prevent oil from reaching near shore waters around these islands. This is an instance where the use of chemical dispersants in the open sea should be considered. Mechanical means of oil containment and retrieval are not likely to be completely effective, particularly in heavy seas. For example, if a slick is headed for the west end of San Miguel Island, it could be dispersed chemically in the open sea (at a distance of greater than 5 miles from the island). This might prevent impacts on birds and mammals from oil and disturbance from cleanup or other near shore spill related activities. If oil does reach rookery beaches, cleanup is not recommended. Near shore activities of any type should be kept to a minimum.

Coastal wetlands. Coastal wetlands in California have suffered a 67 percent reduction in area since 1900. Most have been dredged out to make marinas and harbors or filled to make building sites. Most wetlands remaining in southern California are small, some are degraded, but they are critical to coastal ecology.

Wetlands are vital stopover points and feeding areas for local and migratory birds along the Pacific Flyway. They also serve as temporary stores of nutrients in the form of biomass. Nutrients are released at a relatively constant rate, preventing pulses. This, as well as their function as feeding, spawning, and nursery areas, makes wetlands important regulators of offshore ecology as well (Cowell 1978).

Wetlands are particularly vulnerable to impacts from oil spills. If oil enters these complex environments (Figure 2), it may flow throughout the wetlands via systems of water channels, and can easily become trapped among marsh plants or worked into sediments. In addition, organisms known to be sensitive to oil (such as birds, larval fishes, and invertebrates) are often concentrated in wetlands.

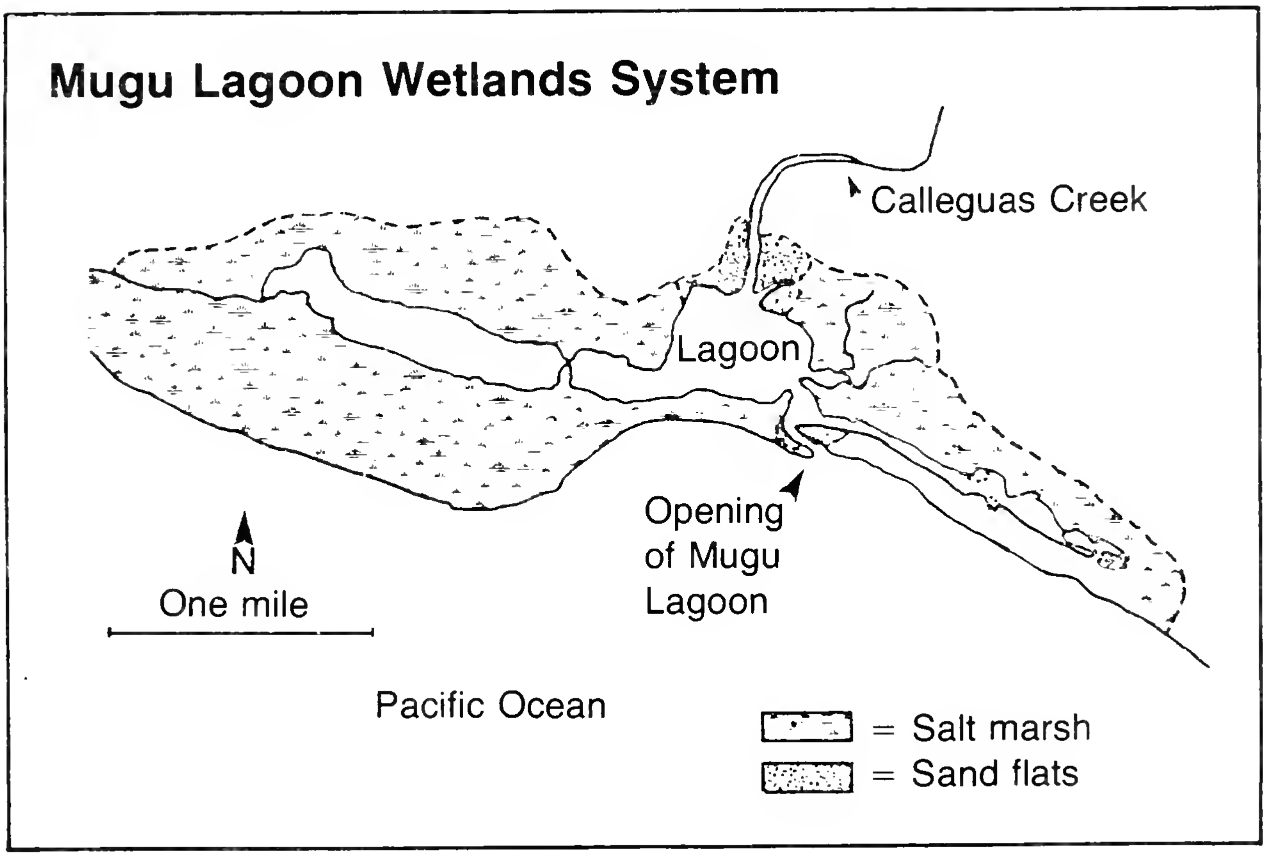

Figure 2. Mugu Lagoon wetlands system.

Hence, protection of wetlands should be given high priority in spill response. Five wetlands sites were identified in the Santa Barbara Channel. For all of these sites booming strategies were developed for the channel by which the wetlands communicate with the sea. If oil can be prevented from entering the narrow opening, the larger system can be protected. Oil containment booms can be used either to block the entrance channel or to divert oil from the channel onto an adjacent beach. In times of low flow (California summers) a sand berm quickly constructed may prevent oil from entering wetland areas. Methods must be developed and tested for each site.

DEVELOPMENT OF STRATEGIES TO PROTECT BIOLOGICALLY SENSITIVE AREAS

Identification of biologically sensitive areas is only the first step in the spill response planning process. Specific strategies and methods to protect each site must then be developed. To protect Channel Islands rookeries, Clean Seas, Inc. acquired the equipment and the capability to apply chemical dispersants from helicopters. Some dispersant was also stockpiled at Clean Seas' primary storage facility in Carpinteria (Figure 1). Permission to use dispersants must be obtained from the On-Scene Coordinator (OSC) with supporting recommendations from various other Federal and State agencies. Such permission has been granted only a few times in U.S. waters. To make response planning effective, Government agencies and cleanup cooperatives should begin now to develop specific guidelines for dispersant use. Like any other spill response activity, dispersant use should be well thought out, planned, and practiced before a spill occurs. Needed biological and chemical research, as well as debates among scientists and regulatory agencies about where and when, should begin immediately. It will most likely be too late to prevent harm to the Channel Islands if these decisions are left to be debated until a spill has occurred.

To protect coastal wetlands, specific booming strategies were developed and tested at each site. To decrease reaction time, eight 40-foot trailers were equipped with gear designed to protect specific sensitive areas. The trailers were then stationed at various points along the coast, as near as possible to the biologically sensitive areas to be protected. Other equipment (such as barges, skimmers, work vessels, and storage tanks) is stationed at four locations along the coast (Figure 3). In time of emergency the network of equipment and personnel is monitored and controlled from a mobile command post.

GUIDELINES FOR MINIMUM IMPACT OIL SPILL CLEANUP

When oil contaminates shorelines, decisions must be made regarding whether to attempt cleanup and which cleanup methods to use. Clean Seas' area of responsibility was surveyed and the various habitat types identified. The various cleanup options for these environments were reviewed, including the

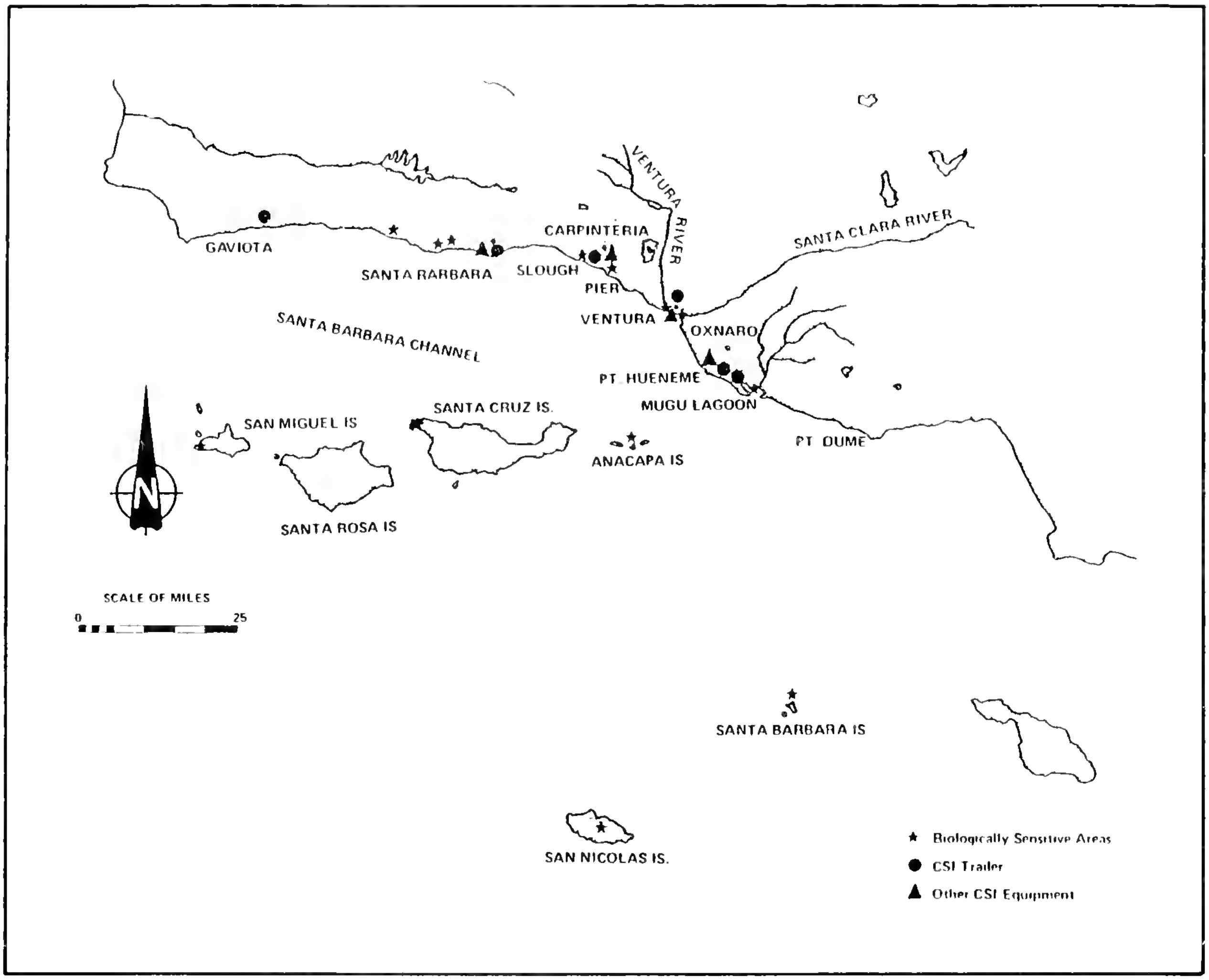

Figure 3. Location of biologically sensitive areas and CSI equipment in the Santa Barbara Channel area.

"no cleanup" alternative, and recommendations were made for each habitat type. Ecological effects of oil spill cleanup along with general cleanup recommendations were reviewed in an earlier paper (Lindstedt-Siva 1979). A summary of those recommendations follows.

Pinniped Haul-out and Rookery Beaches

Cleaning is not recommended for beaches used by pinnipeds as haul-out areas or rookeries. An exception in the Santa Barbara Channel could be two mainland beaches used as nighttime haul-out sites by harbor seals. These could be cleaned during the day when not in use by seals. Human activity on beaches used by pinnipeds or in near shore waters should be avoided.

Salt Marshes

Most salt marsh ecologists agree that marshes are sensitive to all forms of disturbance and nearly impossible to "clean" following an oil spill without causing ecological impacts in addition to those already caused by the spill (Teal 1962, Cowell et al. 1972, Ranwell 1972, Cowell, 1978). Even low-level foot traffic can damage plant root systems, work oil into sediments, and affect soil structure and drainage patterns. Extreme cleanup measures such as bulldozing, raking, and draglining should be ruled out. Cutting marsh vegetation is not recommended merely to remove visible oil. If it is absolutely necessary to prevent contamination of an unoiled part of the marsh, it should be done with aquatic weed cutters from boats at high tide. A preferred method is to flush with low-pressure water from boats at high tide to gently direct free oil from the marsh to a collection point (Westree 1977). Foot or vehicle traffic through a marsh is not recommended (Cowell 1978). Under most circumstances, no cleanup at all is probably the best course to follow. The advice of salt marsh ecologists is vital during both preparation of spill response plans and during a spill emergency.

Rocky Beaches

Rocky intertidal environments are best left to self clean in most cases. High-impact cleanup methods like steam cleaning, hydroblasting and scraping are not recommended. Flushing with low-pressure water can often remove lighter oils without harming attached animals and plants.

Sandy Beaches

The most common spill cleanup method used in the United States has been removal of oiled sand using earth moving equipment (URS 1970). In the United Kingdom, dispersant spraying and burning have also been used (Nelson-Smith 1968, Bloom 1970, Dolan and Bowersox 1973, URS 1977). These methods all may add to the ecological impact already caused by the spill (Nelson-Smith 1968, Bleakley and Broaden 1974).

Unless there is danger of contaminating unoiled areas, most sandy beaches are probably best left to recover by natural means. Hand methods can be used to remove large globules like tar balls. However, public amenity beaches must sometimes be cleaned. At such times when the esthetic goal of removing visible oil may take precedence over the ecological goal of minimizing impact and should be recognized as such. If earth moving equipment must be used, care should be taken to minimize disturbance to surrounding areas (backshore dunes, marshes, etc.) and sediment removal should always be kept to a minimum.

A technology being developed in Canada as part of the Arctic Marine Oil Spill Program (AMOP) may enable removal of oiled sand with minimum substrate disturbance. Russell et al. (1979) have developed a rotating belt with large nails protruding from it. Nails penetrate the sediments and oiled sand sticks to the nails and the belt. Unoiled sand does not. This equipment shows promise and developments should be watched with interest.

Tidal Flats

Sand and mud flats, particularly those associated with estuaries, support rich communities of burrowing invertebrates and are important feeding areas for birds. If tidal flats become oil contaminated, sediment removal, and/or traffic through the area is not recommended. Dispersant use is also not recommended unless it could be applied before oil strands (Crapp et al. 1971). Small crews in boats at high tide could use low-pressure water flushing techniques to sweep floating oil to a boomed collection area.

Harbors and Marinas

Harbors and marinas often receive heavy commercial shipping and recreational boating use. Some also may support rich benthic and/or fouling communities. Booms, skimmers, and other mechanical oil recovery devices generally work well in the sheltered waters of harbors and marinas. Dispersant use is not recommended. Flushing with low-pressure water to remove oil from jetties, sea walls and pilings is recommended over steam cleaning or other high-impact methods.

IMPLEMENTATION OF RESPONSE PLANNING BY CLEAN SEAS COOPERATIVE

A spill response manual was developed for Clean Seas, Inc. (CSI 1978), based on previous recommendations (Lindstedt-Siva 1976) and results of field testing. The manual describes methods to protect identified biologically sensitive areas (e.g., boom deployment patterns for wetlands openings) and includes cleanup guidelines. It is a working document, put into practice through regular drills and training exercises. The importance of such exercises cannot be overemphasized. Methods are tested and practiced and logistical problems worked through. The key is to make as many response decisions as possible before a spill occurs.

Equipment is stockpiled and carefully maintained by Clean Seas staff (e.g., all engines are run regularly, much equipment is stored on or in trailers) so that response in an actual emergency can be as rapid as possible. Fast response capability is essential in a spill response plan designed to influence the outcome of the spill situation, e.g., prevent oil from reaching biologically sensitive areas.

After the response plan is implemented and training exercises ongoing, of course, everyone involved hopes the plan will never have to be used. The Clean Seas, Inc. response plan was activated in December 1977 when a small spill occurred offshore, not far from a wetlands site identified as a biologically sensitive area. Clean Seas responded rapidly, boomed the mouth of the wetlands and oil was prevented from entering it. This experience showed that a response plan designed to minimize ecological impact can work in practice.

DISCUSSION

The importance of goal-directed, prioritized oil spill response planning cannot be over emphasized. Spill control equipment, trained personnel, and time to respond always will be limited during a spill emergency. It is not possible to protect an entire coastline, so resources must be focused into areas and actions where they can accomplish most.

If the primary goal of spill response is to minimize the ecological impacts of oil spills, it is essential that ecologists participate in spill response planning as well as actual spill response. Ecologists should be among the first responders at the scene of a spill (i.e., on primary spill response teams), whether such teams are formed by government or industry groups. Both groups have been slow to seek this input. The appointment of Field Response Coordinators by the Fish and Wildlife Service is a step in the right direction. Similarly, biologists are beginning to appear on industry response teams (CSI 1978, SC-PCO 1979). The Society of Petroleum Industry Biologists has offered to assist industry cooperatives in finding biologists to serve on response teams.

After more than a decade of research into the effects of oil on organisms, it is now time to take a closer look at the question of how these effects can be minimized. Unlike assessing impact after the fact, this research could help influence the outcome of a spill situation.

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DETERMINING ENVIRONMENTAL PROTECTION PRIORITIES IN COASTAL ECOSYSTEMS

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INTRODUCTION

It is well known that the vast majority of United States oil spill incidents occur within coastal waters (73.7 percent in 1976) (USCG 1977). In order to adequately plan an operation to deal with a large oil spill, and to present the On-Scene Coordinator (OSC) and Scientific Support Coordinator (SSC) with the fullest range of options, the potential impact area must be characterized simply and systematically for probable spill damage before the spill occurs. For this purpose, an oil spill vulnerability index has been developed after an extensive literature search and personal investigation of three massive oil spills (*Metula*, *Urquiola*, and *Amoco Cadiz*) and several smaller incidents (including spills under tropical and ice conditions). A list of major spill studies that were used to determine oil impact on various coastal environments is presented in Table 1.

THE OIL SPILL VULNERABILITY INDEX

Coastline environments are classified on a scale of 1 to 10 in terms of potential vulnerability to oil spill damage. The index is based primarily on the residence time or persistence of spilled oil within each environment, although initial biological impact is considered. The persistence of oil is determined primarily by physical processes (waves, tides, and when present, ice movements)(Gundlach, et al. 1978, Owens 1978).

The vulnerability index is summarized below; details are presented in Gundlach and Hayes (1978b). Environments are presented in order of increasing vulnerability to oil spill damage.

Exposed, Steeply Dipping or Cliffed Rocky Headlands

Based on observations during the *Urquiola* and *Amoco Cadiz* oil spills, oil was generally kept 5 to 10 m offshore by waves reflecting off the steep rocky coast. Damage was minimal and oil that did strike the coast was rapidly removed by wave activity.

Table 1. Oil Spill Studies Containing Details of Oil Impact on Shoreline Environments

Oil spill	Date	Type & amount of oil	References
WWII tankers U.S. East Coast	Jan. to June 1942	Various; 533,740 tons	Campbell et al. (1977)
Torrey Canyon Scilly Isles, U.K.	Mar. 1967	Arabian Gulf crude; 117,000 tons total; 18,000 tons on shore	Smith (1968)
Santa Barbara Blowout, CA	Jan. 1969	California crude; 11,290 to 112,900 tons total; 4,509 tons on shore	Foster et al. (1971)
Arrow Chedabucto Bay, Nova Scotia	Feb. 1970	Bunker, C; 18,220 tons total	Owens (1971)
Metula, Strait of Megellan, Chile	Aug. 1974	Saudi Arabian crude; 3 percent Bunker, C; 53,000 tons total; 40,000 tons on shore	Hann (1974) Blount (1978)
Urquiola, La Coruna, Spain	May 1976	Persian Gulf crude; 2 percent Bunker C; 110,000 tons total; 25 to 30,000 on shore	Gundlach and Hayes (1977) Gundlach et al. (1978)
Amoco Cadiz Brittany, France	Mar. 1978	Arabian Gulf crude; 223,000 tons total; 60,000 on shore	Gundlach and Hayes (1978a) Hayes et al. (1979)
Peck Slip Eastern Puerto Rico	Dec. 1978	1,500 tons, No. 6 oil	Robinson (ed.), in press

Eroding Wave-Cut Platforms

Deposited oil is removed relatively rapidly (several weeks) from this environment because of its wave-swept condition. At the *Metula* site, all traces of oil were eliminated from wave-cut platforms by the time of our first site survey 1 year after the wreck.

Flat, Fine-Grained Sand Beaches

Compact, fine-sand beaches inhibit oil penetration; and, as they generally respond slowly to wave or tidal activity, the depth of oil burial is minimal. As indicated at several oil-affected, fine-sand beaches in Spain and France, indigenous amphipod populations are likely to be destroyed, although recovery may occur over the following several months. Cleanup is simplified by the presence of a hard substrate.

Steeper, Medium- to Coarse-Grained Sand Beaches

As observed at the *Urquiola* spill site, oil burial and penetration may be great on depositional medium- to coarse-sand beaches. Cleanup tends to grind oil into the beach because of the loose packing of the sediment. After a major spill, oil from the beach face is eliminated by natural wave activity usually within months.

Exposed, Compacted Tidal Flats

As observed at the *Metula* and *Urquiola* spill sites, oil does not readily adhere to, or penetrate into, the compact surface of these sand or mud flats. However, biological damage can be very extensive. At the *Amoco Cadiz* spill site, millions of heart urchins and clams were killed within the shallow subtidal zone. Perhaps in a truly biologically oriented index, this environment should be rated higher.

Mixed Sand and Gravel Beaches

On mixed sand and gravel beaches in Spain, oil from the *Urquiola* rapidly penetrated 30 cm into the sediment. Cleanup is difficult without damaging the beach, by removing the sediment.

Gravel Beaches

Investigation of the *Urquiola* site revealed that oil penetrated most deeply (60 cm) into uniformly coarse-grained sediment. Followup study of a gravel beach at the *Amoco Cadiz* site revealed that oil persisted as fresh mousse at least until 8 months after the spill.

Sheltered Rocky Coasts

Spilled oil tends to coat the rough surface of rocks within sheltered environments. Because wave energy is low, oil may persist several months to years. The resident biological community is usually abundant and diverse, and very likely to be damaged or destroyed during an oil spill.

Sheltered Estuarine Tidal Flats

Several sheltered tidal flats in France remained severely contaminated at least 8 months after the spill. Even in places where mechanical cleanup operations succeeded in removing surface oil, the interstitial water was still oiled. The latter condition may have a negative effect on recolonization.

Sheltered Salt Marshes and Mangrove Coasts

Salt marshes and mangroves are the most productive portion of the coastal zone. It has been shown that large amounts of oil in the marsh environment can be devastating, as at the *Metula* and *Amoco Cadiz* spill sites. At West Falmouth, Massachusetts, the effects of the 650 ton *Florida* spill (No. 2 oil) were detectable for at least 7 years (Krebs and Burns 1977). With lesser quantities, the marsh may be able to recover (e.g., *Urquiola* site), although repeated spill incidents are usually damaging (Baker 1971).

There is evidence that heavy oiling of mangroves can be equally as damaging. The most notable case occurred in southwest Puerto Rico where the *Zoe Colocotronis* caused the defoliation and death of one hectare of red and black mangroves (Nadeau and Berquist 1977). In another case (Florida Keys oil spill), Chan (1976, 1977) reports that mangroves were killed where the sediment or pneumatophores were oiled. Recently, the defoliation of 1.9 hectares (0.5 acres) has been documented by our research group at the site of the *Peck Slip* oil spill in eastern Puerto Rico. Defoliation and probable death seemed to occur where both sediment and prop roots were heavily oiled. Recovery of a mangrove ecosystem takes an estimated 20 years (Odum and Johannes 1971).

METHODS OF APPLYING THE VULNERABILITY INDEX

The integrated zonal method is the primary technique of application. This method has been adapted from the zonal method developed by Hayes, et al. (1973) to classify large sections of the Alaskan Coast for the Office of Naval Research. The addition of a biological component to these field studies presents an integrated approach to determining environmental protection priorities. The index has been applied to Lower Cook Inlet under sponsorship of the Alaska Department of Fish and Game and National Oceanic and Atmospheric Administration (NOAA)(Hayes et al. 1976, Michel et al. 1978). Currently, work is underway to apply this system to Prince William Sound at the entrance to Port Valdez, Alaska and to Puget Sound, Washington. Both projects are sponsored by NOAA. The method is briefly summarized as follows.

Before field work, available literature, aerial photographs, maps, charts, biological keys, and tidal data are collected and analyzed. Field work begins with an aerial reconnaissance of the study site flown at low tide. Observations are recorded verbally on tape and photographically with a 35 mm camera. A sampling interval is selected on the basis of geomorphic and habitat variability, and the desired detail of the study. Areas of particular economic or ecologic importance are selected for further study. Each sampling station includes a beach topographic profile, three equally spaced sediment samples, a hand drawn sketch (to force inspection of all aspects of the areas), and photographs from various angles. Primary producers, dominant consumers, and standing stock biomass are assessed. Typically, this includes census of intertidal sedentary and mobile macrofauna, and examination of sea grasses, and algae. Ecologically or economically important species are studied in particular. If available, field data are compared and analyzed with respect to other (e.g., Fish and Wildlife Service) data from the study site.

During and after field work, the data are compiled and analyzed. Sediment samples are sieved and calculated for grain size and related statistical parameters (Folk 1973). Biological data are analyzed by application of standard statistical techniques.

After data compilation, the coast is divided into geomorphic divisions. Habitats are superimposed onto these divisions. The last stage is the construction of detailed maps (using USGS 7.5-foot or 15-foot topographic maps as a basis) indicating the determined index value of each coastal environment. Such features as areas of particular biological importance, major recreational centers, access roads for cleanup equipment, and mooring points for booms also are indicated.

CONCLUSIONS

The combination of the integrated zonal method and the oil spill vulnerability index presents a cohesive method of classifying shoreline environments as to potential damage from oil spills. A format of detailed maps indicating index value, biologically sensitive and major recreational areas, and access points for cleanup enables the OSC to make more rapid and responsible decisions concerning the allocation of cleanup equipment. In addition to prespill contingency planning, these methods also are applicable for post-spill damage assessment.

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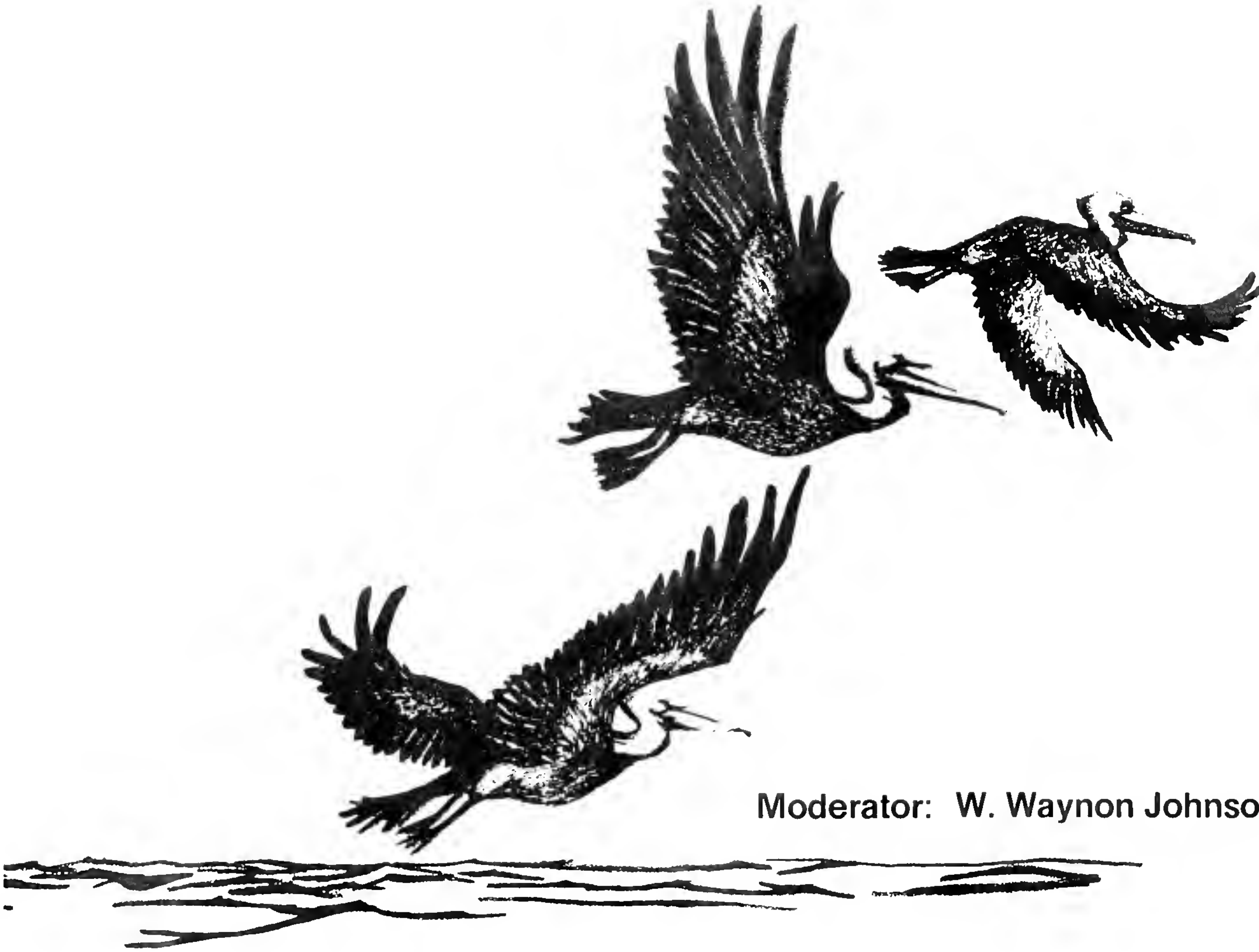
IV

Oil and Hazardous Substances Response Techniques



Moderator: W. Waynon Johnson

PRIORITY SCHEME FOR CLEANING UP INLAND OIL SPILLS

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INTRODUCTION

By statutory authority spelled out in the National Contingency Plan, the U.S. Environmental Protection Agency (EPA) is the designated agency for supplying the On-Scene Coordinator (OSC) for inland oil and hazardous substances spills. In many EPA Regions, the U.S. Coast Guard will respond and supply the OSC for certain inland spills. For example, in Region V, the U.S. Coast Guard will supply the OSC for spills originating within 10 miles of a major navigable water body.

When the U.S. Coast Guard supplies the OSC, the function of the EPA member and other members of the Regional Response Team (RRT) is to serve as advisors to the OSC in terms of the cleanup operation. Therefore, a priority scheme is a valuable tool towards insuring that the cleanup operation will be efficient, cost effective, and environmentally acceptable.

In the past, priority schemes have been generated for inland spills through the informal efforts of the RRT representatives after the spill has occurred. This was the case at the Nepco 140 Oil Spill in the St. Lawrence River in June 1976. A priority scheme was formalized 6 weeks after the spill had occurred. EPA, through the efforts of its contractor, the URS Company, provided a suggested scheme which was reviewed by the International Joint Response Team and forwarded to the OSC for his use. The scheme was considered useful by the OSC, but most of the natural resources management representatives felt that such a scheme would have been more useful had it been formulated earlier.

APPROACH

What makes inland spills different from coastal or marine spills?

Volume and Type of Oil Spilled

Over 3.4 million gallons of oil were spilled into inland waterways during 1977 (USCG 1978), out of a total of 17.6 million gallons. This pollution was the result of 2,841 different incidents out of a total of 10,620 incidents. The type of oil spilled is also important, since mostly refined products are involved in inland spills.

Physical/Chemical Characteristics

In fresh water, oil is more soluble and more easily emulsified; thereby enhancing its toxicity to aquatic organisms.

Damage to Fresh Water Resources

Ground water contamination is more likely to occur from an inland spill than from a coastal or marine spill. In Region IV, several cases of ground water contamination from pipeline breaks have occurred and have been documented (Smith 1973). Likewise, similar events have been reported in Canada (Dennis 1977).

Fresh water as a resource has more "uses," many of which are obligatory, i.e., drinking water. Thereby fresh water spills are potentially more harmful to human health than coastal water spills, particularly when a water body that is used as a public water supply has been affected.

Damage to Natural Habitats

Likewise, a variety of habitats, i.e., small streams and ponds or large lakes, are likely to be affected due to the nature of oil movement.

Riverine rapid stream. It is interesting to note that the few studies in the United States which documented the impact of oil spills on fresh water habitats have involved spillage into rapid stream communities (Bugbee and Walter 1973, Schultz and Tebo 1975).

In the spill reported by Schultz and Tebo, the oil was instantaneously discharged into the high gradient stream, flowing downstream as a slug into a recreational lake.

The ecology of these areas is extremely sensitive to oil pollution as shown by these previously mentioned studies. The effect to exposed indigenous macroinvertebrate populations was acute and drastic. However, in the study of Bugbee and Walter (1973) some of the affected populations became reestablished from stream drift within 3 years following the spill.

Rapid streams are also the most difficult to protect after a spill. The velocity of the stream, the topography of the stream banks and the stream configuration are such that there is very little entrapment or natural containment. These conditions often severly hamper getting equipment into place which would entrap and contain the oil.

These rapid streams are an important fisheries resource usually for sportsmen who enjoy fishing for the cold water species.

Riverine--slow moving steam. As the topographical gradient decreases, the physical and ecological characteristics of a stream change. Consequently, a different set of factors must be considered to determine the impact of spilled oil. In most watersheds, the slower moving water is present in the lower end of the hydrological gradient, where there is a large volume of water in the stream channel.

These stream types are more commonly impacted from navigation-related incidents. As a whole, slow-moving rivers are apt to be more impacted by man's activities from population centers that have developed on the shorelines. More typically, this type of community will support a warm water fishery, particularly an urban fishery. Although an oil spill on a slow-moving stream may not move as a slug and have the same devastating effect as on the rapid stream habitat, the impact may be determined in terms of diminished populations or outright fish kills. Physical features such as backwaters and oxbow formations may be present, which encouraged the formation of wetlands and floodplain woodlands.

Lacustrine--ponds and lakes. One normally thinks of ponds as being smaller and shallower than lakes and having different ecological features. When an oil spill occurs in a watershed that includes ponds, these ponds serve as natural sumps or collection points for floating oil. The impact of the accumulated oil can be drastic, particularly if it has toxic components that are water soluble or increase the biomass exposure probability.

Lakes. One usually thinks of lakes as being much larger, deeper bodies of water with different, more complex physical, chemical characteristics. These features create conditions that must be considered when evaluating the sensitivities of the ecology and also the impact from oil spills. In large lakes exposed to winds with a variety of shorelines, the impact will vary with shoreline. The sensitivity relative to the effects of an oil spill also will vary with shoreline types.

Endangered Species

Most of those aquatic species now listed on the endangered species list--(Department of the Interior 1979) from the obscure Maryland darter to the Bald Eagle--live in or depend upon the fresh water domain for their existence.

Locally Important Species

Although some fresh water species may not be considered endangered or threatened, on a local basis, some species may be important esthetically or commercially. In this latter case, these species may be especially endeared to the local populace. In the NEPCO 140 Spill, the Great Blue Heron was classified into this category.

Wetlands

The term wetlands has different connotations for different people; the coastal and marine oriented think of salt marshes and salt meadows, the fresh water biologist thinks of emergent *Typha* marshes, cedar swamps, acid bogs, and floodplain woodlands. In this paper, the term wetlands applies to the fresh water domain.

Fresh water wetlands are considered ecologically important in terms of primary production. Fresh water wetlands serve as prime productive areas for waterfowl and fisheries species, flood and storm water control, protection of subsurface water resources, recreation, domestic wastewater treatment, erosion control, open space, and esthetic appreciation.

THE PRIORITY RANKING DECISION SCHEME

Generating a Priority Scheme

A priority scheme for cleanup is concerned primarily with those areas that have already been contaminated with oil. The premise is that the oil should be removed as quickly as possible to minimize the environmental damage. This same premise is applicable for generating a priority scheme for shoreline protection as well.

Prioritization of cleanup is more realistic for inland spills than shoreline protection because oil movements are so rapid in many of the inland waterways that there usually is very little time before the oil has impacted a shoreline. It is imperative that the cleanup effort be initiated as soon as possible to minimize the effects of the oil migrating to adjacent clean shorelines.

The first step in cleanup planning is to organize the impacted shorelines in order of cleanup need. To do this, the position of a particular shoreline in the priority list will depend upon the answers to the following questions:

1. What is the biological or cultural value of the shoreline?

2. What is the degree of oil contamination?

3. What is the degree of potential for oil to migrate from the contaminated shoreline to an uncontaminated shore?

4. What is the spatial distribution of the affected shorelines relative to each other?

These questions have been identified and addressed by Foget et al. (1979) in a manual prepared by Woodward-Clyde Consultants, Inc. for the EPA.

In this paper I have expanded upon these elements and added some special considerations for use in the fresh water domain.

Biological-cultural value. This is by far the most important and controversial element of a cleanup priority scheme. It is in this area that the OSC will request the RRT members to provide some technical insight for conducting the cleanup operation. A modification of this scheme, as shown in Table 1, was used at the NEPCO 140 spill emphasizing the sociological usage of the shoreline and biological productivity (URS 1976).

Table 1. Scheme for Biological Cultural Value of Contaminated Shoreline

Shoreline use	Relative value (1-9)	
Public interest	High	(7-9)
Recreation: Public beaches, boat ramps, marinas, scenic views		
Health: Water supplies		
Industrial		
Harbors, river frontage	Low	(1-3)
Cooling and process water intakes	High	(7-9)
Natural areas		
Wetlands, waterfowl rookeries and refuges, commercial fishing and sports fishing areas, endangered or protected species habitat (high biological productivity)	High	(7-9)
Rocky shores, low intensity use areas (low biological productivity)	Low	(1-3)
Private interest	Medium	(4-6)
Privately owned waterfront properties, docks, and beaches		

The RRT would not necessarily provide the information for evaluating the following elements of the cleanup priority scheme. The OSC may have sufficient staff to assess these factors or may rely upon field representatives of the various RRT member agencies.

Degree of contamination. This has the same weight in the cleanup decision scheme as the biological-cultural sensitivity factor with the same range of relative values (1-9).

The extent of contamination of a shoreline is dependent upon the type of oil, type of substrate, currents and wind direction, and intensity. The degree of contamination can be assessed by the depth of surface contamination or penetration and extent of coverage for that particular shore.

For spills that affect inland water courses, stream bank vegetation and debris affects the degree of contamination. In many cases, this material serves as a natural oil absorbent; however, it can also be difficult and time consuming to remove.

Oil migration. Oil that has contaminated a shoreline may pose a serious threat to other clean shorelines downstream of the affected area. In the case of inland spills, water currents, wind direction, and intensity will affect oil movement. Even oil that may be entrapped can be moved if a wind shift occurs. In a riverine environment with alongshore and currents, oil can be moved from one site to another.

This factor is one that incorporates the likelihood of change in the physical conditions, namely, the weather. A storm front moving through the spill affected area can change the wind direction, intensify wave action; thereby, moving the oil from one site to another.

This potential must be evaluated and given a weighted numerical value; 0 = no likelihood for change, 4 = change is imminent.

Spatial distribution. It is possible that more than one shoreline will be given the same cleanup priority value according to the decision scheme. In this event, the upstream areas should be given priority for cleanup; therefore, any residual oil lost during removal will be contained at the downstream site.

Use of the Priority Scheme

The OSC can use the priority ranking decision scheme (Figure 1), as a guide in selecting when and where he should implement cleanup measures. As conditions change or as new information becomes available, the OSC can use the decision scheme to reorder the cleanup priorities.

The following are some hypothetical spills that are presented as test cases to illustrate the utility of a decision scheme for generating a priority scheme.

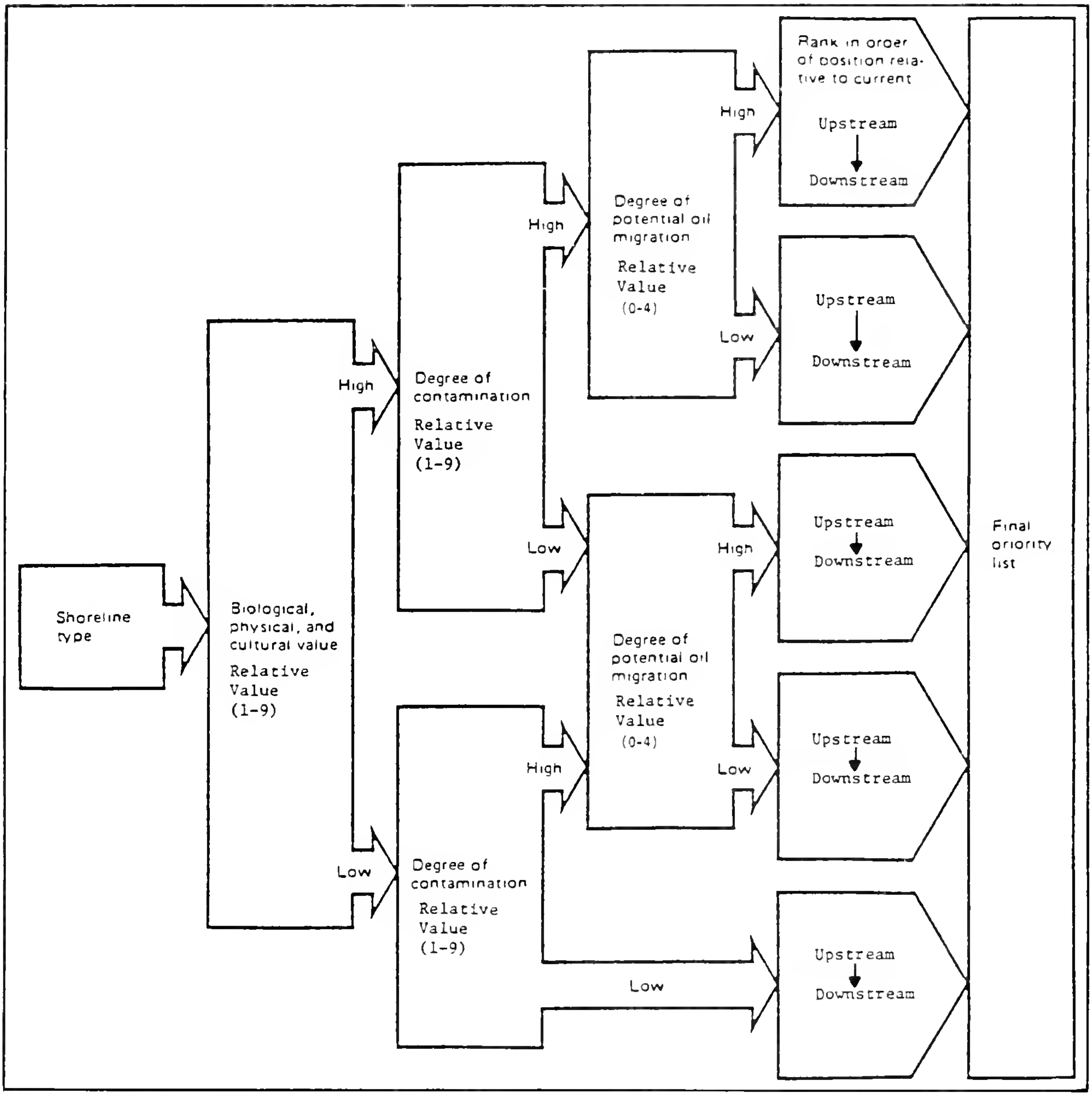

Figure 1. Decision guide for cleanup priorities (modified from Foget et al. 1979).

SCORING MECHANISM FOR INDIVIDUAL SHORELINES

Hypothetical Case No. 1 (Figure 2.)

A major oil spill has occurred in October from a renegade barge colliding with the Interstate 90 Bridge crossing the upper reaches of the Mississippi River near La Crosse, Wisconsin. The oil, a jet fuel No. 4 destined for the Twin Cities airport, has contaminated extensive fresh water wetland and floodplain woodland areas within the confines of both Federal and State waterfowl refuges. Downstream from these refuges is a river side colony of privately-owned cottages with a gravel beach that also has been contaminated by the spill.

Figure 2. A typical oiled fresh water marsh as mentioned in hypothetical case No. 1.

Biological and Cultural Value

Natural areas. These include: Wetlands, waterfowl habitat and refuges, and protected species.

Score 9

Out of a possible 9

Degree of contamination. Extensive shoreline contamination of dead emergent vegetation, dead tree snags with some accumulation occurring in heavy pockets. No evidence of penetration was available.

Score 7

Out of a possible 9

Oil migration potential. A wind shift is likely to occur as meterological conditions change during the next 72 hours resulting in a movement of the now pocketed oil from the shoreline into the river channel.

Score 4

Out of a possible 4

Spatial distribution. The downstream shoreline is a gravel beach that is part of a bluff that juts out into the river. (The upstream shoreline receives priority over the downstream area.)

Score 20

Out of a possible 22

Hypothetical Case No. 2 (Figure 3.)

A major spill of No. 6 fuel oil has occurred from a tank storage in Laconia, New Hampshire on Lake Winnisquam. The wind has blown the slick across the lake from the facility against a group of uninhabited islands with irregular shorelines.

Most of the islands have light accumulations high up the rocky cliff littoral zone with some accumulation in small coves. These islands are State owned but are not inhabited and are only occasionally visited by boaters.

Biological and Cultural Value

Natural areas. Factors to be considered here are: low intensity oil, nonrecreational areas, and low biological productivity.

Score 1

Out of a possible 9

Figure 3. A typical oiled rocky shore as mentioned in hypothetical case No. 2.

Degree of contamination. Light accumulation of heavy oil of high viscosity is deposited as a 10 cm band on the upper littoral zone on the rocky shoreline.

Score	1
Out of a possible	9

Oil migration potential. The oil is stranded out of reach from wave action. The mean air temperature is not conducive for oil bleeding from rocks into the water.

Score	1
Out of a possible	4

Spatial distribution. This is not applicable.

Score 3

Out of a possible 22

Hypothetical Case No. 3

A million gallon spill of Bunker Oil occurred in late July from a power generating facility located north of Oswego, New York on Lake Ontario. Just north of the power plant is a large State-owned and operated campsite/beach that has been heavily contaminated with most of the oil coming ashore at this point. The intake for this facility's water supply is 100 yards offshore in 3 meters of water.

Biological and Cultural Value

Natural areas. A publically-owned recreation area with a close-to-shore water intake needs consideration.

Score 9

Out of a possible 9

Degree of contamination. Extensive surface contamination with a heavy fuel oil has occurred but it is easily accessible with cleanup equipment.

Score 7

Out of a possible 9

Oil migration potential. An extensive amount of oil is in the water, but not on the beach. A wind shift could move the oil to an adjacent wetland area. A wind shift is predicted within 36 hours.

Score 4

Out of a possible 4

Spatial distribution. This is not applicable.

Score 20

Out of a possible 22

The cleanup scheme presented is not to be used to rationalize when a cleanup operation can be terminated. The benefit of this scheme is to provide the OSC with a basis to make critical decisions for allocating limited resources in a time constraining situation.

SYNOPSIS

It is not that the ideas presented here are so novel or innovative.

Basically, this scheme is a formalization of information flow that should occur between the various interest groups represented on the RRT and the OSC.

The object of cleaning up spilled oil is to diminish the exposure time of the oil to the living components of that portion of the biosphere that is affected. This includes man as an affected party as well as the simplest form of life present. A priority scheme should incorporate subjective factors as well as real and natural forces that must be considered by the OSC.

One of these factors is the influence of public opinion. The public voice may be the combined outcries of many individuals who have the same common complaint or it may be the voices of a few vociferous individuals who may be more concerned with their particular welfare. This is not to say that all outcries and criticisms will be satisfied, but at least some of the rancor will be diminished when the public discovers that its concerns have been recognized and are being addressed.

Any cleanup effort can be challenged by the public. The way to mitigate these challenges and criticisms is to be aware and focus upon these concerns prior to the spill such as when these concerns are addressed in a prespill contingency plan that incorporates cleanup priority schemes.

The OSC does not want to be forced to "react." He would prefer to act as the prime motivator to insure that activities are performed according to a prescribed plan of action.

The important point is that everyone is in this together working towards a common goal of minimizing the environmental damage from oil spills.

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CONTAINMENT AND RECOVERY TECHNIQUES

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You have heard the French expression "deja vu," meaning that a person feels he has been in this place before. In working with this group, I am experiencing "deja vu." Your workshop breakout sessions this morning were excellent. The points that you made were right on target. Looking back to the beginning of 1967, I was the only man in the government who was designated as an On-Scene Coordinator (OSC). To watch the field grow these 12 years has been amazing. The States have assumed their rightful role, but more than that, the Federal Government has exerted the kind of leadership that is necessary. The public has come to expect such leadership. I hope that we never shirk that kind of duty. Now, I would like to reflect on our progress in oil containment and recovery.

I started cleaning up oil spills in the stripper fields on north Louisiana and south Arkansas when I was 12 years old. It was my job to take care of the brine production water pit because every rain would break the pit. Then, suddenly the oil would run down to the neighbor's farm pond and every time that farmer would lose a blue ribbon calf. My uncle, who owned the oil leases, got tired of paying for those calves. Many a morning I hitched a team of mules to a wagon and took a dozen bales of straw and mopped up the neighbor's farm pond.

This brings us up to 1969 when the Santa Barbara offshore well blow-out occurred. If you are wondering why straw was used on that spill, it was I who ordered the initial 3,000 tons of it. I think I cleaned out every horse stall in California. The field has progressed in response and cleanup technology since then, of course.

The importance of cleanup technology became apparent during the *Torrey Canyon* incident in March 1967. I was privileged to be a member on the technical team that cleaned up that spill. Three million gallons of dispersants were used in an attempt to put down the oil off the Cornwall Coast. The entire nearshore estuarine communities were completely wiped out. I understand that in those days the dispersants used were petroleum based, solvent based materials with some surfactants. The Army troops were dumping some of the materials out of the drums when tea time came. They had some 20 to 30 drums of their daily allotment left, so they merely threw them over the cliffs.

Biological damages were observed when all the grazing animals were killed. The following year a green fur coat of algae covered that entire coast.

Sooner or later the algae dies, drops off the rocks, flies blow it, and another situation occurs. Additionally, the oil on the beaches was attacked by the dispersants. The dispersants caused the oil to penetrate the sand column, lubricating each particle of sand and causing the particles to separate from each other. Consequently, the beach lost its integrity and became quick. As a direct result of the use of dispersants, the spring tides carved out immense sections of beaches.

The same situation occurred following the casualty of the tanker, *Ocean Eagle*, in San Juan where hotel owners had to replace, at $15.00 to $20.00 per yard, some of the manmade beaches when dispersants had been used in that area. Since then, several generations of dispersants have been manufactured. Most assuredly, these dispersants are less toxic. They do, however, represent an additional pollutant when applied to an oil spill.

I wrote the dispersant policy for this country in 1968. Because I was privileged to have worked in a wildlife and fisheries unit, I understood this country's dedication and agreement to protect migratory waterfowl. One of the tenets regarding dispersants allows for their use when wildlife migratory waterfowl species are in danger. Another provision permits their use when personal safety is threatened and fire occurs. At that point, the OSC may prescribe these materials for fire control and safety rather than oil pollution control.

Since the policy was written, there has been a major effort in the country to produce good surface barriers, known as booms. The U.S. Coast Guard has been the most successful in developing an open sea containment boom that will withstand more than 1 knot of current with which most surface booms are confronted. In other words, the oil is stripped underneath the boom in 1 to 3 knot currents. Most booms fail at greater than the 1 knot current.

In three cases of wild wells off the coast of Louisiana, dispersants were used as water was being applied from barges onto the burning platforms to try to keep them from completely oxidizing below the surface of the water. One platform had 20 production slots, 20 producing wells, 7 of which were on fire. While the oil burned (about 80 percent of it probably would burn), we tendered booms down wind with tugs in a "Y" formation. The oil was collected in the "Y" configuration and was skimmed from the surface of the water onto a barge. The material that was recovered was placed on a storage barge which was tethered to the skimmer barge. It was a very cumbersome operation and was moderately successful. I say this today because there is no country that can absolutely contain and recover all of the oil spilled on the high seas or in fast flowing streams. The technology simply does not exist.

The purpose of the Regional Response Team (RRT) going into these matters of priority is to cut the problem into workable size pieces so we can determine the location of that amount of oil that can be safely recovered. At this point, we still know more "do nots" than "do's" in spill containment.

Another tenet of our dispersant policy states that chemical dispersants can be used when they result in the least environmental damage. Here is the loophole that causes debate over the use of physical recovery of oil versus chemical dispersants. The RRT can help resolve this debate. Specifically, the U.S. policy favors physical recovery of the oil.

A lesson that I learned in England and France, both on the *Torrey Canyon* spill and later during the *Amoco Cadiz* spill in 1978, was that people in these two countries do not enjoy the ownership privilege of natural resources as we do in the United States. The priority in England is to keep the beaches clean for the holiday. There is little or no thought given to the marine resources. One cannot fault that government for trying to protect what its public perceives as its highest priority.

The French government's highest priority is to protect the marine resources. Each time a spill occurs off the Brittany Coast, extensive efforts are made to move lobsters and oysters, to try to boom off certain estuarine areas as well as possible, and to physically recover the spilled oil. However, 77 million gallons of oil can be overwhelming, requiring the involvement of Army troops.

In this country, there are approximately 100 private oil spill contractors who, since 1970, have established themselves as a new type of business. The United States depends mostly on contractors; no Federal or State people actually do the cleanup. For the most part, it is entirely contracted. (Europeans do not have this kind of business.) In my judgment, the basis for our policy of picking up oil and physically removing it from the beaches comes from France. France's intention was to disturb as little as possible, and maintain beach integrity and habitats.

We have learned to deflect oil in our inland areas. No one would ever string a boom across the Mississippi River or the Missouri River. We can, however, deflect that oil into "least current" eddies and similar environments, and then recover it by using vacuum devices or sorbents. Many kinds of commercially developed sorbents have been marketed since 1970. Some of these are expensive; however, they can be reused. We have developed continuous rope polyethylene surface oil removal equipment. In the northern part of this country, the "Slick Licker," a continuous belt that removes the oil, is used. Another device commonly used is called the "Oil Mop."

In coastal areas confronted with waves of oil coming in from offshore, trenches and pits are dug with a back hoe. The oil is funneled into these trenches and pits by the tide. As the tide goes out, the neck of the trenches and pits is closed off. Then, vac-oil trucks, which have become popular in all parts of the country, pump the pits, using many types of skimmers, such as duckbill skimmers. The skimmers are suspended right above the surface of the water, and the force of the vacuum pulls the oil into the trucks. Oil covering large areas can be cleaned up in this fashion. Harbor skimmers in use today have been federally funded, and the Federal Government has developed prototypes. The U.S. Navy uses skimmers to keep its harbors clean. There have been many cooperatives formed all over the country. All of the offshore paltforms have contingency plans involving contractors who can respond quickly using surface recovery devices.

In the early days, most of the labels or the advertisements for dispersants used the three magic words: "nontoxic," "available in large quantities," and "biodegradable." About the time that we became concerned about contents of dispersants, we put certain requirements to which a manufacturer must adhere in our Annex X of the National Contingency Plan (40 CFR 1510). Certain data also must be sent to the U.S. Environmental Protection Agency (EPA). Subsequently, EPA has approved certain dispersants. We received the necessary data from about a dozen manufacturers so we now know what is in the material. We have established its toxicity, at least based on the studies of four species of test animals.

The reason that all information is not publicized widely is that the government is under the Privacy Act (P.L. 94-183). Certain manufacturers do not want such information to become public. However, an OSC calling on the EPA representative can get those materials which are least toxic and which are most effective in ranked order. Effectiveness tests are required in the submission of these data.

There are certain oils, however, on which dispersants should not be used. They are the Navy specials or bunker C oils. These kind of heavy oils, particularly in the cooler climates, respond to dispersants as liver would respond to Ivory Snow. These oils can never be emulsified. Fish nets can pick them up.

Dispersants were used off the East Coast on a continuous bleeding of oil from a sunken tug this past year. The priorities at that point indicated that the beaches around Long Island should be saved for the swimmers in July. The judicious application of dispersants was viewed as a way of avoiding oil on shore. We applied dispersants in a much smaller amount than the manufacturer's specification indicated, but we did demonstrate that dispersants correctly used, could be effective.

Tests are being conducted jointly by EPA and industry. The U.S. Coast Guard is helping because we want to learn more about the efficiency of some of these materials. Most of the dispersants depend on mixing energy to create an emulsion. Once mixed and the emulsion forms, the current helps carry the oil to other areas of the environment. The effect of dispersants are cosmetic for the most part; there is nothing magical about them. Micro-organisms through biochemical oxygen demand (BOD), will eliminate most of the oil through partial or total oxidation and evaporation.

The U.S. Coast Guard has done the most to advance the technology of recovering and containing oil on the high seas. There are limitations, of course. However, the U.S. Coast Guard has an extremely fast capability of laying out some of the high speed barriers for containment. Its Air Deliverable High Speed Pumping System (ADAPTS) has been used to save at least three supertankers. The U.S. Coast Guard deserves praise for taking a world leadership position by developing this technology.

AVAILABILITY AND MOBILIZATION OF MANPOWER AND EQUIPMENT BY FIELD RESPONSE COORDINATORS

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It is most important to remember that as a Field Response Coordinator you are an advisor to the On-Scene Coordinator (OSC). To avoid confusion and misunderstanding during Federal spill incidents all decisions and actions must be coordinated with the OSC. He has the final word.

Imagine that it is 3:30 a.m. The date is December 23, 2 days before Christmas, and the phone rings. A barge carrying 100,000 gallons of No. 6 fuel oil is hard aground and leaking. There are sensitive marshes and waterfowl concentrations in the area.

Some basic questions must be answered to respond properly to this type of incident. Who is closest to the spill site and can provide on-site information? Chances are that you are not going to be there immediately. What are your manpower needs--immediate and future? Will this be a 1-day operation, or will it extend for 6 or more weeks. What are your equipment needs--here again, immediate and future? Where is the manpower and equipment located? How can this manpower and equipment be mobilized? Who should be contacted? Obviously, preplanning is the key to answering these questions.

Let us answer one question at a time. Who is closest to the spill and is concerned with wildlife? It could be someone from a wildlife refuge, State wildlife management area, fish hatchery, or a field biologist. These people usually know the area and can provide firsthand information. This individual can usually be contacted by telephone. The person called, however, should be someone you know and trust so that the information can be relied upon.

What are your manpower needs--immediate and future? Are people needed to operate hazing equipment? Are drivers available for boats and vehicles that may be necessary? Will bird-retrieval personnel be required? Crew chiefs will be essential if volunteers are to be used. Will volunteers be needed to run a bird rehabilitation center? If so, with FWS supervisors? Maintenance people will be necessary to keep the equipment at the rehabilitation center in working order. Experienced aerial observers will be needed. The U.S. Coast Guard on its aerial overflights will provide as much help and information as possible, but they are more interested in looking for oil. An observer can be sent with them, or they will schedule flights for you.

What are your equipment needs--immediate and future? Depending upon the weather, the location of the spill, and the response time, it may be possible to use bird-hazing equipment. In this regard, some questions should be asked about the hazing equipment. Where are the propane exploders and pyrotechnics? Where can helium balloons be obtained? In the larger metropolitan areas, look in the yellow pages of the telephone directory under "Balloons" or "Advertising Specialities." Birds could be hazed from boats operating in the spill area. If boats are used, experienced drivers will be needed. Where can planes with pilots be obtained? Planes can be used very effectively to haze birds.

Where is the bird-retrieval equipment? This can include boats with drivers, vehicles with drivers, retrieval nets, boxes with tops, burlap bags, ponchos, maps of the area, compasses, binoculars, and two-way radios. The radios are needed for efficiency and safety of retrieval efforts. If a bird-retrieval crew needs help, it can be sent to them. A first aid kit is essential for every field retrieval crew. Aerial observations can pinpoint the concentrations of waterfowl, either for field retrieval or for harassment. Where is the bird care and rehabilitation equipment? Appendixes E and G of Saving Oiled Sea Birds (1978), published by the American Petroleum Institute, list the physical requirements for a bird care facility and the equipment that should be on hand or readily available.

Where is the bird rehabilitation center going to be located? If this can be determined in advance, you are ahead of the game. Where is the hot water source? We learned from hard experience during the ATC-133 spill in 1978 at our Reedville, Virginia rehabilitation center that hot water is not easy to come by for the inexperienced. The final solution, however, was simple. With a system composed of a steam cleaner, a clean 250-gallon home heating oil tank, and a pressure pump, we had all the hot water we needed. Such equipment is usually available locally. How are the birds going to be dried? Will it be with pet dryers, or will expertise and equipment from organizations such as the International Bird Rescue and Research Center be requested?

How will the soapy water from the bird cleaning operation be disposed? It should not be dumped into a storm sewer, a septic tank, or on the ground because of the oil and soap contamination. It will have to be deposited in a sewage system capable of treating large concentrations of soap and oil. At Reedville, our wastewater was pumped into a tank trailer and disposed of properly. A great deal of newspaper is used in this operation. How will it be disposed of? For sanitation purposes it may be necessary to use latrines or porta-pots if indoor plumbing is not available. Suppliers of detergents for bird-washing should be identified ahead of time; Amberlux, for example, may be hard to get on short notice 100 miles from a major metropolitan area. Portable swimming pools for birds also should be located in advance; finding portable swimming pools in the middle of the winter is not easy.

Where is the manpower and equipment located? Is it staged all in one place or is it scattered throughout the area? How can the availability of manpower and equipment be determined and how can they be mobilized? The obvious thing to do is to establish contact with the FWS project leaders in your area of responsibility. The Animal Damage Control (ADC) staff has expertise in the use of bird-hazing equipment. The refuges probably have capture equipment and holding facilities and may be able to supply a building for use as a rehabilitation center. Establish contact with State conservation and water resources departments. In Maryland, the Water Resources Administration is very highly organized. They have spill trailers with containment equipment and can be at any spill site within the State in 2 hours. They also have a limited amount of bird-hazing and cleaning equipment. Establish contact with volunteer groups. They will probably be the main source of manpower. Establish contact with the U.S. Coast Guard Marine Safety Officer (MSO) and the EPA offices responsible for your area. The MSO can pass on a lot of information and he can refer you to people who can help with preplanning for a spill.

What can be expected from the various State and Federal organizations and private groups? Manpower in the form of regular employees and Young Adult Conservation Corps (YACC) enrollees can be expected from the Federal installations. A word of caution, however: don't strip a station of all its manpower because the hatchery or refuge must continue to operate. During the ATC-133 spill, the refuge managers contacted provided two or three people at a time, because they wanted their employees to get some experience in oil spill work. YACC enrollees were also used.

The Divisions of Wildlife Refuges, Fishery Assistance, and Ecological Services usually have boats and drivers. Bird retrieval equipment could be a long-handled net from a hatchery or refuge. ADC and refuge personnel will probably have ready access to hazing equipment. Law enforcement agents may also have access to hazing equipment. Buildings may be available at refuges and hatcheries. Whenever requesting a vehicle or a boat, ask for a driver. Two-way radios may be available from law enforcement or wildlife refuge personnel.

State and Federal organizations and private groups also have substantial information on local waterfowl concentrations and sensitive areas. In Maryland and in Virginia there are 7,000 miles of Chesapeake Bay shoreline. Part-time Field Response Coordinators (FRC's) cannot possibly know an area this size like the back of their hands. They have to rely on local information from people both within and outside of the FWS. Law enforcement can provide the necessary permits and enforcement. I would also assume assistance in crowd control would be provided if that type of help is needed. Research can provide expertise in areas of oil toxicity and environmental impacts. Our various disease laboratories can provide information on disease and pathological problems. When requesting lab and research assistance, go through the Regional Pollution Response Coordinator (RPRC) and the Regional Director. Some State organizations can provide essentially the same expertise available from the Federal organizations. State agencies probably have more local information on sensitive areas; they have contacts with the local environmental groups, fish and game clubs, and rod and gun clubs; and, as in the case of Maryland, California, and a few other States, bird-cleaning equipment.

Volunteer groups, of course, are going to be the main source of manpower for cleaning stations. Depending upon weather conditions and how the OSC feels, volunteers may or may not be used on field retrieval. It may be more appropriate to utilize FWS personnel when working under adverse weather conditions. Human health and safety is of ultimate importance during field operations.

The OSC or his designee can be of great assistance in obtaining emergency support equipment and supplies during spill emergencies. We have to specify what is required, e.g., solid waste disposal facilities, wastewater disposal facilities, etc. It is important to consolidate the list of needs and funnel it through the FRC to the OSC. This will eliminate waste and duplication of orders.

Let's go back to our imaginary spill. Through preplanning, the following information is known: the individual closest to the spill, the manpower and equipment needs, the location of the manpower and equipment, and the people to call to mobilize the necessary manpower and equipment. In closing, I want to stress that the OSC should be informed of what you need and what you are planning to do. Obtain his concurrence and approval before making any commitment of manpower or funds. This is especially important if reimbursement is expected. If something is ordered and the OSC does not think it is necessary, you are liable for the cost.

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ENDANGERED SPECIES CONSIDERATIONS

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The Endangered Species Act of 1973 (16 U.S.C. 1531, et. seq.) was amended on 10 November 1978, but the basic requirements for agency responsibilities under Section 7 remains unchanged. It says that "each Federal agency shall, in consultation with and with the assistance of the Secretary, insure that any action authorized, funded, or carried out by such agency does not jeopardize the continued existence of any endangered species, or threatened species, or result in the destruction or adverse modification of their critical habitat."

ENDANGERED SPECIES PROTECTION

The Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS) have been delegated the lead responsibility for endangered and threatened species protection in the United States but they still share this responsibility with other agencies. All Federal agencies have to comply with the requirements of the Act, but the FWS must be more conscientious than others. The Defenders of Wildlife brought a case concerning hunting regulation into the District Court of Washington, D.C. It was a citizen's suit under 11(g)(2) of the Endangered Species Act. The FWS was going to permit duck hunting a half hour before sunrise. The Defenders felt that the resulting limited vision could encourage a hunter to shoot the wrong bird, perhaps listed species which happen to be in the area. Although there was an attempt to assure the judge that it was unlikely that this would occur, the judge did not agree. He held that the FWS, more so than any other agency, is obligated to conserve listed species.

SECTION 7 COMPLIANCE

Citizens anywhere can challenge the activities of the FWS and any other Federal agency on their compliance with Section 7. Section 11(g)(2) is the reason why the Defenders of the Wildlife suit on the hunting regulations happened. The only restraint in the 11(g)(2) activity is the forum -- it has to be brought into the Federal District Court where the action is occurring.

On 6 February 1978, the Director (FWS) issued instructions concerning intraservice consultations to all Regions. In his memorandum he stated that the FWS is expected to fulfill its Section 7 responsibility similarly to other Federal agencies. That is, all FWS activities and programs must be reviewed for Section 7 compliance and necessary consultation must be conducted pursuant to these requirements. There are endangered species specialists within each Region to assist. There is a form, a procedure, and a format to follow. The Director has determined that he will sign these intraservice consultations. Biological opinions will be formal. There will be no in-house relaxation just because a colleague is preparing the biological opinion. FWS activities must be reviewed as provided by the guidelines and the recommended biological opinion has to go to the Director for review and concurrence.

The regulations on Section 7 are being redrafted now. They have to be amended to some extent to incorporate the exemption criteria that were decreed by the 1978 amendments to the Endangered Species Act. There are interim guidelines and regulations dated 22 January 1979, that are available to assist FWS personnel in fulfilling their Section 7 obligations.

USE OF BIOLOGICAL STUDIES

Often a better understanding of the impact of a spill on listed species or their critical habitat is needed, and can be obtained only by conducting biological studies. The results of these biological studies should be forwarded to the Regional Office and then to Washington. In this way we can compile all the information that we are gathering and use it to avoid adverse effects in the future, correctly respond to inquiries concerning spills in sensitive areas, and better assist in cleanup activities.

COMPLIANCE PROBLEMS

Species Protection and Protection Recommendation

The biggest problem in pollution response as it relates to the Endangered Species Act is being responsible for recommending procedures for the protection of the listed species and their habitats. You have to know where they are and that requires very close communication with the On-Scene Coordinator (OSC) and the establishment of rapport with volunteers who are able and eligible to work with listed species and their habitats. Also, communications among your own staff and with our endangered species specialists in each area are vital.

Binding Advice

In the 1979 proposed revisions of the National Oil and Hazardous Substances Pollution Contingency Spill Plan, Section 1510.36A3, there is one sentence which says that advice provided by the FWS or by the NMFS on cleanup actions that may affect endangered species shall be considered at all times and shall be binding on the OSC, unless in his judgment actions contrary to this advice must be taken to protect human life. It appears to illustrate serious concern about operating within the confines and the constraints of

Section 7 of the Act. Its importance is also in that it assigns an additional burden on the FWS personnel who are on scene. Given the circumstances of the situation and the time constraints, especially in the containment process, the FWS specialists have to make some very quick decisions. And, the decisions are based on a rapid evaluation, considering that they are binding. If our advice is going to be carried out, we have the obligation of insuring species/habitat protection.

Containment Process and List of Dispersants

It would appear that the containment process and the list of chemical dispersants are very sensitive areas of concern. It is difficult to plan on knowing exactly what happens when a dispersant is used, where it goes, and what the ultimate effect is going to be. However, the U.S. Environmental Protection Agency is very careful with its recommendations on the use of a dispersant. We can anticipate FWS involvement through recommendations on listed endangered species that are threatened along with their habitats as they relate to that use. The obvious constraint to response is not fully knowing what to expect. It is possible that the use of a dispersant may create further abuse to the habitat of listed species, even more so than letting the oil stay there or using a more conventional method of dispersal.

Use of Volunteers

Another problem that can be anticipated in responses on pollution plans is the use of volunteers. The value of volunteers cannot be overly stressed or appreciated. As stated in the FWS's pollution response plan, wherever possible that use should be proportional to the experience of the individuals whenever the possibility of handling endangered or threatened species exists.

Habitat Effect

Another common problem in pollution response is the effect on the habitat. Before rushing out to remove the oil from the habitat, it should be determined whether the natural erosion of the oil, or some alternative removal method is more conducive to reclamation activities and to the subsequent rehabilitation of the listed species. Sometimes with beach cleanup, we are faced with the problem of esthetics. If all the oil is removed we have served everyone well. This could be at the expense of listed species and their habitat if to remove the oil one has to traverse the habitat with heavy equipment.

Again, knowledge of where the habitats are, knowledge of what species are there, mobility of those species, and when they are there all need to be considered. The obligations of the FWS is that work within the confines of Section 7 of the Endangered Species Act includes secondary effects of all of our actions. This is mandated by the Coleman case in Mississippi. The highway interchange was not going to disect the habitat of the Mississippi sandhill crane but the secondary effect of subsequent development would have had an adverse effect on the habitat. We have to consider all of our actions, such as the highway interchange, and how they interrelate with all of the other variables in the area, even factors that are not related to the oil spill. After considering all these influential factors we can make our recommendations as to how best to protect these species and their habitats. Advice and recommendations to the OSC must relate to the habitats of the species, and not just the individual organism.

CONTAINMENT OR CLEANUP

There are two time frames involved in pollution responses. One is the immediate containment of the spill. The second one is the cleanup activities of rehabilitation and reclamation. Those activities, while very critical, are not in the same time frame as the containment activities. Sometimes, taking those extra 3 minutes to make a telephone call to an endangered species specialist might reduce an adverse impact from a well-intended cleanup activity.

ENFORCEMENT OF ENDANGERED SPECIES ACT

The adequacy of FWS response to the demands of pollution response will be evaluated by citizen, conservation, and environmental groups, and perhaps industry as well. Our contributions are subject to judicial review under Section 11(g)(2) of the Act. Accordingly, the administrative record of everything that transpires in the implementation of any Section 7 consultation is a necessity for all parties.

WILDLIFE REHABILITATION TECHNIQUES: PAST, PRESENT, AND FUTURE

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INTRODUCTION

Research in oiled bird rehabilitation has developed through a trial and error approach. We shall attempt to outline what has happened in this highly specialized area and to indicate the status of oiled bird rehabilitation today. Recommendations are made to further improve treatment techniques by systematic research and improved response capability.

THE PAST

As early as the 1830's, (Waterton 1832) controversy raged among ornithologists as to what was responsible for keeping birds waterproof. Over the years two schools of thought emerged (Elder 1954). One school insisted that waxes secreted by the uropygial gland and distributed over the feathers during preening allowed the birds to stay dry in their environment. The other school protested vigorously that the waxes were needed to maintain the feathers in a supple condition and that waterproofing was due to alignment on a microscopic level. Today (Fabricius 1959) the latter hypothesis predominates but the belief that waxes are responsible for waterproofing is alive and well in the minds of the public, many academics, and some wildlife biologists.

In 1942 a description of one of the first recorded attempts to clean oiled birds appeared in a U.S. Department of the Interior wildlife leaflet. F.A. Lincoln (1936) described using mild white soap and drying with a stream of compressed air in the direction of the feathers. Stedman, (1952) used a mixture of corn oil, neatsfoot oil, detergent, waxes, solvent, and water. The paste was applied to oiled birds who were then allowed to preen the substance from their feathers. After 10 days the birds were shedding water although they still looked oiled and probably were. Whether they survived is unknown.

Throughout the fifties and sixties a variety of cleaning agents was tried: powdered chalk, fuller's earth, mascara remover, butter, lard, detergents, castor oil, mineral oil, and waterless handcleaner. Methods reached the ultimate with the immersion of oiled ducks in an ultrasonic cleaning device filled with a detergent solution (Brown in Aldrich 1970). The result of all these experiments was the same: birds were not left in a condition that would allow them to survive in the wild; most of the birds had to molt before release was possible, and that took months.

Research during these years was a varied, far from concerted, effort. Attempts were made to find substitutes for the uropygial secretion. Spermaceti and lanolin in hexane, waxes in solvents, waxes in detergents, and waxes alone were applied to the feathers of cleaned birds. All substitutes failed to produce waterproof plumage. It was suggested (Beer 1970) that the induction of molting to replace affected feathers might be a solution to the oiled bird problem. However, molt is one of the least understood and most stressful physiological functions in birds. Extensive research would be needed to develop practical induction of molt. Even then, the stress of molting added to the stress of captivity would surely result in low survival.

The search for answers to oiled bird treatment was not limited to feathers. The effects of oil, both external and internal, were investigated. Lincoln (1936) suggested that contaminated birds ingested harmful amounts of oil. Hartung (1963, 1964) proved this beyond a reasonable doubt when he administered, by stomach tube, oil to domestic mallards. The birds developed loss of mobility, diarrhea, loss of coordination and balance, and tremors. Necropsy showed enteritis and lipid pneumonia as well as changes in the liver, pancreas, and kidneys.

Dehydration appears to be another side effect of oil ingestion. For some time it was thought that sea birds did not drink seawater but obtained needed fluid from food only. It was assumed that intake of salt water would result in dehydration and that the nasal gland, particularly well developed in birds, produced a secretion that rinsed seawater from sensitive nasal membranes. Schmidt-Nielsen et al. (1958) disproved this with the discovery that fluid excreted by the gland was almost twice as salty as seawater. Sea birds did drink seawater and excess salt not processed by the kidneys was eliminated through the nasal gland. Ticehurst (1938) provided another clue to the effects of oil ingestion. After observing oiled sea ducks seeking fresh water he stated: "they appear to be poisoned by something in the oil which they swallowed when preening to rid themselves of it." Other investigation indicated that the ingestion of oil may interfere with the salt and water transport mechanisms in the intestinal musosa (W. N. Holmes, personal communication). Dehydration is seen in many oiled birds and this finding would explain it.

The wreck of the *Torrey Canyon* off the coast of Britain in 1967 and the resulting spill of approximately 119,000 tons of crude oil affected thousands of sea birds. For the first time there was worldwide focus on the problems encountered with oiled birds. The cleaning attempts, both in England and France, despite a joint effort, were dismal failures. The disaster did have one beneficial side effect. As a direct result of the wreck, the British Subcommittee on the Rehabilitation of Oiled Sea Birds of the Advisory Committee on Oil Pollution of the Sea set up a research unit at the Department of Zoology, University of Newcastle upon Tyne, to investigate the problems of oiled bird rehabilitation.

The unit initiated a multifaceted attack on the oiled bird problem and reviewed the literature, sparse as it was, and, in addition to studying pathology, stress, behavior, nutritional demands, and water repellency, reexamined recommended cleaning agents, and investigated new ones. Solvents were eliminated early in the study as being too toxic. It was decided to concentrate on easily obtainable nontoxic household detergents. The methods developed emphasized thorough rinsing, early swimming, and no medication. These techniques produced high release rates but the annual reports of the unit (Clark 1970, 1971, 1972, 1973, 1974) fail to mention how long the birds were held in captivity.

The Santa Barbara spill in 1969 and the San Francisco Bay spill in 1971 called attention to the plight of the oiled bird in this country. Unprepared Government wildlife agencies were unable to cope with the thousands of water birds impacted in both spills. Cleaning stations and bird care facilities were organized by ecology groups who recruited staff from the hundreds of private citizens anxious to help the affected animals. Contradictory advice was forthcoming from veterinarians, ornithologists, zoologists, and naturalists. Nonsense usually prevailed. In the early days of the San Francisco spill loons were given dishes of grain and grebes, at one point, were encouraged to eat bread soaked with milk. The majority of the birds were cleaned with mineral oil which was followed by a liberal application of cornmeal to absorb the excess mineral oil. Both rehabilitation attempts can be considered failures as essentially no birds were released after Santa Barbara and only 3 percent were released after the San Francisco spill, most after 9 months in captivity.

After the San Francisco spill,Standard Oil of California funded research by the National Wildlife Health Foundation in the use of organic solvents for cleaning oiled birds. The birds were washed in a series of warm solvent baths followed by drying with forced warm air (Naviaux 1972). Later, practical experience with this method showed that absorption through the skin and inhaled fumes produced toxic effects that were demonstrated by torpor, loss of equilibrium, hyperactivity in some species (loons and grebes), and very high mortality in birds weighing less than 300 grams. The toxic effects were not limited to birds. Without respirators and protective clothing, cleaning personnel complained of lightheadedness, euphoria, skin rashes, and headache. The solvent was flammable and was not recommended for use by untrained personnel or in spills involving large numbers of birds. Although birds cleaned with solvent were ready for release within days of cleaning, it was obvious that a safer, nontoxic cleaning agent was needed desperately.

After several oil spills involving wild birds on the east coast in the midseventies, oiled bird treatment and its results started attracting the attention of both Government and industry. Of an estimated 3,113 birds cleaned between 1973 and 1976 only 16 percent were released (Perry et al. 1978). No records were kept during any of the rehabilitation attempts. It is probable that most of the birds released were not in a condition that would permit survival in the wild. The cleaning agents used were Gulfsol 10 and 20, Shell Sol 71, Basic H, Liquid Concentrate, Foresight, L.O.C., and Pink Lux.

From 1976 to 1978 the International Bird Rescue Research Center (IBRRC), with a grant from the American Petroleum Institute, investigated commonly used cleaning agents and some agents that had not been used. In all, 14 detergents were tested (Berkner et al. 1977). It was found that Lux Liquid Amber, an industrial strength biodegradable detergent, was capable of removing most oils without leaving surfactant residues responsible for lengthy rehabilitation periods.

With the change from "solvent to suds" the lot of the oiled bird improved considerably. Postcleaning mortality dropped substantially and birds weighing less than 300 grams survived through cleaning to release. The first large-scale test of the new detergent occurred in Reedville, Virginia in March 1978. After the sinking of a barge off Smith Point, 423 birds contaminated with Bunker C were collected. With support of the U.S. Coast Guard, the rehabilitation effort was organized by the Fish and Wildlife Service (FWS) and supervised by IBRRC. In spite of an outbreak of avian cholera at the time of the spill, the release rate was 32 percent.

THE PRESENT

What is the state of oiled bird rehabilitation today? Certainly, dramatic progress has been made since the Santa Barbara oil spill in 1969. Because the effects of oil, both external and internal are better understood oiled birds now are treated for hypothermia, dehydration, starvation, and oil ingestion. Care is prescribed on a species level, taking into consideration for instance the special need of the pelagic species to be gradually reintroduced to salt water before release. Birds are now cleaned with nontoxic detergents. This cleaning, combined with appropriate care, produces acceptable release rates within 10 days. (In 1978 IBRRC released 69 percent of the 135 oiled birds received for care that year.) One question often asked today is: "why are high release rates seen so seldom in spills affecting large numbers of birds?" The answer is simple; personnel caring for the birds have had little or no experience, facilities have been woefully inadequate, and support, in the form of supplies, has been almost nonexistent.

With the entry of the FWS into oiled bird rehabilitation, the gloomy picture of the past is changing rapidly. Along with protection of habitat and dispersal of wildlife during spills, the FWS has been charged with the coordination and supervision of professional and volunteer groups who may wish to take part in oiled bird rehabilitation. Both national and regional contingency plans of the FWS provide guidelines for the use of volunteers in oiled bird emergencies. With such action in mind, the FWS has sponsored six oiled bird rehabilitation workshops throughout the country in the last 1.5 years. In these workshops, attended by representatives of local humane, ornithological, and environmental groups, demonstrations and some hands-on training provided an introduction to oiled bird treatment. Also covered in the workshops were contingency planning and the role of industry and State and Federal wildlife agencies during spills. Many of the private groups represented have since developed their own contingency plans designed to integrate with regional FWS plans. Organization like this will minimize the confusion that has plagued past efforts; but release rates cannot be expected to rise dramatically until everyone involved has become thoroughly familiar with oiled bird care. Unfortunately, such experience only can be gained through practice during an actual spill.

The supervision of future oiled bird cleanup efforts by the FWS can ensure data collection needed to develop success predictability. Williams (1978) offers general guidelines, which should be refined to species level, to establish the toxicity of various oils to different species, and to evaluate the success of different rehabilitation methods. Information gathered would improve techniques and lead to standardization of treatment.

There is still some confusion about oiled bird treatment. Many veterinarians, who receive little training in avian medicine in veterinary school, treat the oiled bird much as they would the companion, or domestic animal. Dehydration is rarely recognized, and cathartics, dehydrating in themselves, are administered in order to remove oil from an inflamed gut; corticosteroids, which leave the bird with reduced immunity, are ordered to alleviate stress; antibiotics, which increase the susceptibility to fungal disease, are prescribed as a prophylactic measure; and thiamine is given to prevent thiaminase toxicosis. Many birds have survived for years in captivity feeding on fish known to contain high levels of thiaminase (Swennen 1977). There is hardly any data applicable to the diagnosis and treatment of affected birds. Treatment could be improved considerably by research. Especially needed are: baseline studies, on a species level, of avian hematology and blood chemistry; the establishment of parameters that would clearly define shock thus eliminating the controversy that surrounds its treatment; the study of serum and tissue levels, and the metabolism and excretion of antibiotics in water birds to determine correct dose levels; and research into the nutritional needs of the commonly oiled species.

It might be said that the oiled bird today faces an identity crisis. It is a "political animal" in the realm of partisan politics and is subject to the scrutiny of House Subcommittees. It is a "poor relation" in the field of oil spill cleanup technology, yet it is the dramatic symbol of the environmental cause, and an object of contention to many of those trying to save it. The bird's true position, a complex veterinary medical problem, has, at times, been overlooked.

THE FUTURE

Oiled bird rehabilitation is far from being a simple laundry problem; it is an interdisciplinary specialty combining cleaning techniques, veterinary medicine, and animal husbandry. The successful implementation of cleaning techniques in an oil spill situation requires contingency planning, stockpiling of materials, and site selection for cleaning centers prior to a spill, as well as experienced onsite supervision during a spill. Successful rehabilitation of oiled birds is so complex that we cannot expect great success from impromptu organization at each spill. However, if the resources could be found to maintain a small group of skilled professionals who could be sent to an oil spill site to organize the rehabilitation efforts, the prospects for successful rehabilitation of oiled birds would be bright.

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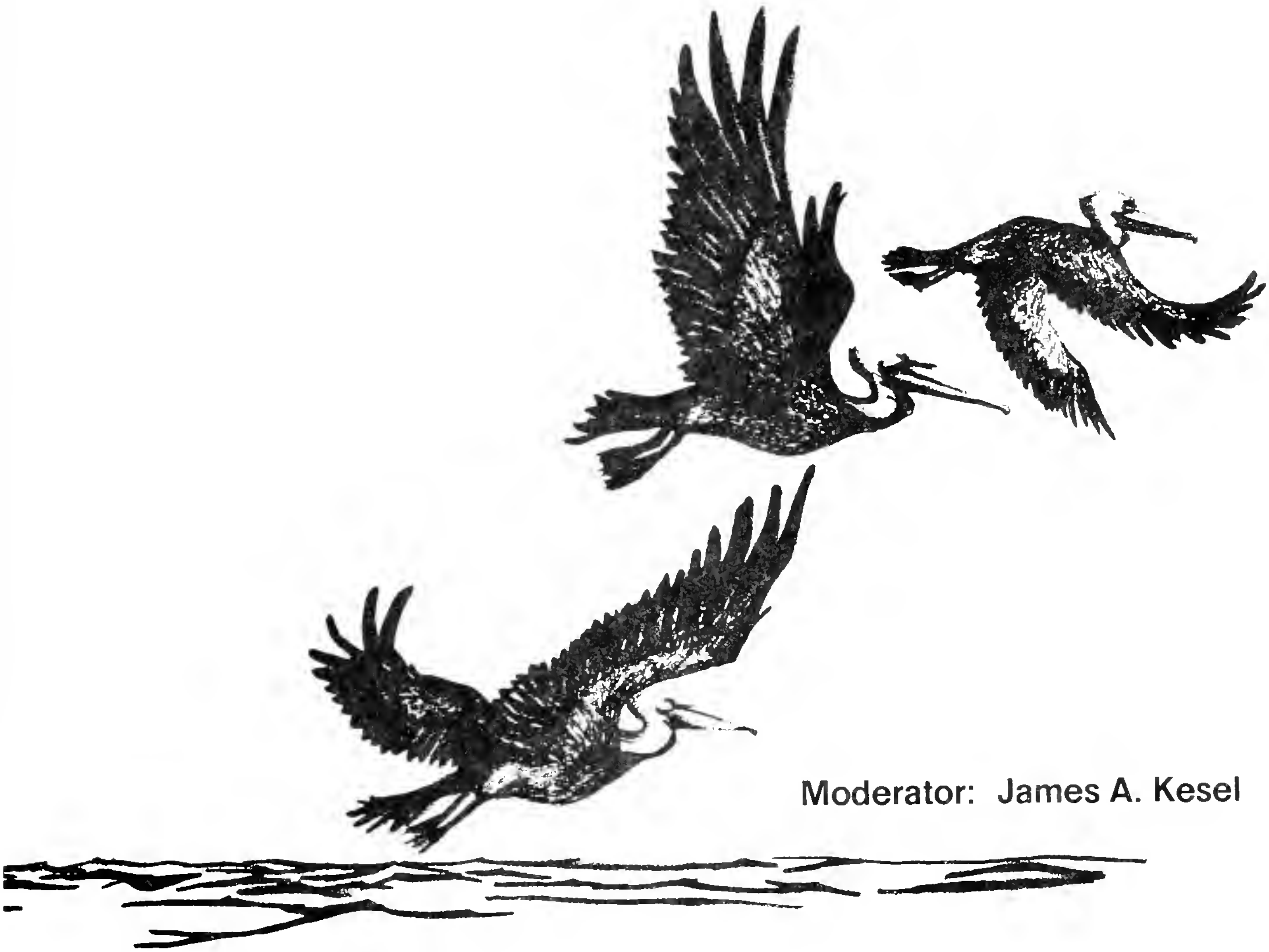
V

Interfacing with the Public, News Media, and Other Agencies in Crisis Situations



Moderator: James A. Kesel

COORDINATION AND OBTAINING COOPERATION FROM VOLUNTEERS AND ONLOOKERS

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During crisis situations, problems arise that would be easier to cope with if more planning had been done. Major oil spills present emergency situations requiring support from many people, and only through a coordinated effort with Federal and State agencies and volunteer groups can operations run smoothly. This paper is based on experience gained on the ATC-133 oil spill in Reedville, Virginia. It will emphasize the need to locate and organize the available resources in an area before a spill occurs. Planning can eliminate much of the mental and physical strain associated with major spills.

The ATC-133 spill occurred on 27 February 1978. The barge grounded off Smith Point in Reedville, Virginia, and spilled 25,000 gallons of No. 6 oil into the water. Twenty-five thousand gallons is not a large spill, but the effects on wintering waterfowl were significant. An estimated 10,000 to 15,000 birds were affected. A total of 423 were captured; 135 were rehabilitated and released back to the wild. This represented a 32 percent release ratio.

During various stages of the operation, 35 Fish and Wildlife Service (FWS) personnel were utilized. The State of Virginia believes that it is not feasible to rehabilitate oiled birds, so it did not supply the necessary manpower to assist us. The volunteer group was untrained and could be used only for bird care.

The Field Response Coordinators (FRC's) recognized that outside help would be needed. They alerted a local volunteer group and a rehabilitation center was set up at the Reedville Fire Station. Although this was to prove inadequate for the number of birds to be brought in, it was a start. Additional help was requested from the FWS Area, Regional, and Washington Offices, The Humane Society of the United States, and the International Bird Rescue Research Center.

The Area Office provided equipment and additional manpower. The Regional Office provided support and guidance, attended meetings with the U.S. Coast Guard, and furnished the Washington Office with updated reports. The Washington Office provided an experienced person in bird rehabilitation and volunteer training. The Humane Society furnished two trained people to assist in bird care and volunteer organization, and the International Bird Rescue

Research Center was contracted to assume overall responsibility of bird rehabilitation.

The local news media (through the U.S. Coast Guard Public Affairs Officer) provided information to the public about the operation (how to report oiled birds, what to do, and what not to do), and asked for materials that would be needed, such as rags and newspapers.

On 28 February, the FRC's held a meeting with the volunteer group. The volunteers received copies of "Saving Oiled Sea Birds" (Williams 1978) and learned what was expected. Volunteer leaders were identified and group responsibilities were established. Although much of the volunteers' work would require on-the-job training, this meeting identified job assignments and numbers of people needed.

Despite these arrangements, the operation was becoming more complex and demanding. Problems were beginning to mushroom. It appeared as though there were 50 people to answer to all at once and not enough hours available to accomplish what was expected.

Oiled birds began coming ashore on 28 February. Recovery teams searched the shoreline each day. Private citizens brought in birds they had captured. The telephone rang constantly with people reporting locations of oiled birds and the news media requesting stories. The fire station was too small to hold all the birds. Bird cleaning operations were relocated in a spacious building that had been used to dry fish nets. U.S. Coast Guard personnel were extremely helpful in building pens, improvising a hot water system, and buying materials that we requested.

Work forces were organized to handle the recording and pretreatment of birds. Other people were assigned to feed, clean, wash, rinse, and dry the birds. The work crews were divided into two shifts, so no volunteer would be overworked. Organizing enough volunteers to assure that the work was done was an overwhelming task.

During this time, a continuous supply hot water system was being developed so washing operations could commence. Many different methods of heating water were tried before full-scale operations finally began on 12 March -- 2 weeks after the spill occurred.

By the second week after the spill, the volunteers were discontent. They were impatient because of hot water problems. They could see little progress being made and were tired of rolling up newspapers, cleaning pens, and feeding and watering birds. The whole operation was taking longer than anticipated, and they were losing interest very rapidly. There were personality clashes. This frequently occurs with volunteers at oil spills. The FRC's tried to resolve such conflicts by taking the time to explain the problems in the operation. A "Quack Board" was devised to keep the volunteers informed of operation progress. Nevertheless, low volunteer morale was not our only concern.

During the same period, birds also were coming ashore in southern Virginia and northern North Carolina. Reedville is 3 miles south of the Maryland-Virginia line, so Service personnel had a huge area to cover. Trips were made to southern Virginia (3 hours away) to set up a bird collection station and enlist additional manpower and equipment. Service supervisors were asking that their people be relieved because normal workloads were piling up. Replacements had to be found. The On-Scene Coordinator (OSC) was demanding that we start washing birds. He was upset that we did not have an adequate hot water system and concerned about the time that was being wasted trying to devise one. We lost our volunteer force on two occasions, but after meetings with them they returned. Those in coordinating positions had been working 17 to 21 hours each day; mental and physical pressures were beginning to show. Each night the coordinators met to discuss the day's events, problems, solutions, and plans for the next day.

After the hot water system was operable and birds were being washed, things began to run more smoothly. Bird recovery had slowed. Our remaining tasks were to complete washing, waterproofing, and, finally, banding, and release.

One other problem delayed our progress: an outbreak of avian cholera in the Chesapeake Bay. Blood samples had to be analyzed before the birds could be released. Finally on April 1 -- 5 weeks after the spill occurred -- the birds were released and except for a Congressional investigation, FWS's involvement was over.

A lot was learned from this experience and the following are ways to improve response for future spills. After what these coordinators went through, any way to be better prepared was well worth trying.

A major problem was dealing with the volunteers. They were elderly. Many were retired from the military. Consequently, they expected a highly organized operation. We could not give them as much attention as they required. One person was assigned to coordinate the volunteer leaders, but he was in charge of pretreatment and had other duties as well. If these volunteers had been trained or been involved in previous spills, there would have been fewer difficulties. Experienced volunteers understand the pressures and the confusion that can occur.

Some of the volunteers who were helping at the Reedville spill had previously attended a leadership training workshop for oiled bird rehabilitation. At this skill session, which was held at the Patuxent Wildlife Research Center in November 1977, tasks for rehabilitating oiled birds were identified.

Since the spill, the FRC's have spent many hours with local groups identifying ways of improving their effectiveness. One volunteer group in Delaware has been involved with us in prespill organization for the past 2 years. These volunteers have been through the problems that arose at Reedville. They have found their own rehabilitation center, which is one less problem to worry about. They have been stockpiling equipment and presently are negotiating with an industrial cooperative for funding to further enhance their preparedness. They have ongoing training sessions, and each person is trained for a certain job. They have a telephone communications system for reporting oiled birds. Their leaders know our coordinators. If a spill occurs, this group will need minimal supervision. The FRC's will be able to concentrate on other responsibilities.

The news media demanded more time than anticipated. After the initial contact was made, we felt that we had a full grasp of the situation and decided to continue handling the news media ourselves. Time that was spent answering questions should have been used in other ways. A Service Public Affairs specialist available continuously during a major spill would prove valuable.

The onlookers did not pose much of a problem. Time was spent explaining cleanup activities and the reason that outsiders could not walk through the building to view the operation. Another volunteer group plans to prepare a handout explaining the operations and the importance of not disturbing the birds.

At Reedville we tried to alternate supervision. One person, referred to as "Duty Duck," would assume overall command for the day. Another would spend the day on field retrieval. A third would assist in whatever way he could. Each day, the FRC's alternated these positions to relieve the pressures associated with overall command. However, this created confusion as the U.S. Coast Guard and volunteers had to work with a different supervisor each day. The FRC in charge should concentrate on overall management and delegate some work to other Service personnel. He should not handle each and every problem personally.

Lastly, to preempt future problems with a hot water supply, a trailer is being equipped that can be used in areas where facilities are limited. After a mobile hot water system and other supplies are unloaded, the trailer will serve as a headquarters to base operations.

We learned all these things the hard way, but through planning we will be better able to handle our next spill. A FRC's responsibilities go beyond the "response only" concept. The potential magnitude of oil or hazardous substance spills necessitates preplanning Servicewise. There will continue to be problems and pressures, but we feel that we have reduced many of them.

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CRISIS MANAGEMENT

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The principles of crisis management hold true whether the crisis is a 63,000,000-gallon *Amoco Cadiz* disaster, one tank car off the track in rural Ohio, or an emotional upheaval within a Regional Response Team.

Every crisis provides the opportunity to experience either pain or gain. Under similar conditions, some people are overwhelmed by a crisis and others seem to grow stronger and better, using crises as stepping stones to improved performance. The natural questions are: "what is the difference?" "Are there 'good' and 'bad' people?"

The inner strength and the coping skills that are helpful in crises can be developed in two ways. First, a healthy self-image and experiencing numerous past crises seem to help in learning to cope with new episodes. The crises can be medical, financial, organizational, or ecological. They all provide good training. Being well organized and having the ability to separate important issues from trivial ones are also helpful traits.

Luckily or unluckily, many people have not been subjected to excruciating crises in their lifetimes. This does not mean, however, that they have to stumble around for years and learn "the hard way" before doing a good job in a crisis.

There is a second, perfectly valid way to learn to develop coping skills, and that way is behavior rehearsal.

When crises and people's reactions to them are analyzed, there are three phases: before, during, and after the crisis. The crisis that "jumps out of the bushes" without warning can be the most devastating, which is why the before phase is so important as far as maximizing positive results is concerned. The elaborateness and thoroughness of preparations should depend on how big the stakes and what the probability is that this particular crisis will happen.

How can a person learn crisis management skills without successfully coping with past crises? The situation is comparable to the young person who cannot get a job because of lack of experience and cannot get the experience without having a job. This problem has been solved by an important discovery that allows the creation of experience in the mind. Experimental and clinical psychologists have shown that the human nervous system cannot tell the difference between an actual experience and an experience imagined vividly and in detail.

It is not necessary to wait around until one is old and gray and have been through the wringer of life to learn to handle crises effectively. This is why behavior rehearsal works.

BEFORE

Anyone who knows how to worry can make behavior rehearsal work. Worry involves: thinking about some future event in gloomy detail; imagining some undesirable outcome very vividly; going over and over the event and dwelling on the terrible outcome; thinking of all the bad things that might happen and how awful they are going to be; conjuring up the worst alternatives and their devastating effects; looking at all aspects of an event as negatively as possible and then moaning about them either silently or out loud. Worry automatically generates feelings of fear, anxiety, and discouragement, which are appropriate to the undesirable outcome being anticipated.

Using a system similar to "worrying," "good" emotions can be generated just as easily as "bad" ones. Constantly picturing a crisis and dwelling upon desirable end results will make the possibility seem more real. Appropriate emotions of enthusiasm, cheerfulness, and encouragement can automatically be generated. The system involves concentrating on a desirable goal, rather than an undesirable one; imagining a favorable outcome for the crisis; assuming that this favorable outcome is possible; arousing a deep desire for favorable results; becoming enthusiastic about them; dwelling upon and reiterating them; thinking about what might happen and how to handle it productively, considering the available options and the advantages and disadvantages of each; taking the most difficult possibilities and dealing with them in advance; putting one's imagination to work; digging out more information, if necessary, and working out solutions.

If this is done and each possibility is worked out in advance, then you will be prepared to handle almost anything when and if it occurs. You also will have the know-how to deal with any unexpected events that may arise. These unanticipated alternatives should be kept as infrequent as possible by spending adequate time doing your "homework."

The beauty of this method is that it can be used by one person all alone without involving a support team or cooperating agencies. It can be done in Newton Corner, Twin Cities, or Anchorage.

Working within one's own mind, important as it is, is just the first level of behavior rehearsal. The second level is doing the same kind of thing involving others on the Response Team. This provides the opportunity to deal with interactions between people and groups and may bring out some conflicting goals. It also allows people to reinforce and educate each other because the thoughts of several people are bound to cover a wider range of possibilities and options than the thoughts of one person.

The third level involves role playing. Cases are set up with particular viewpoints built into each role, and participants have the opportunity to handle them in a practice session. This method is good because it allows participants to learn in a no-risk atmosphere, to try out different styles, and to get private, direct feedback on their performance. Its effectiveness does, however, depend on the expertise of the person who makes up the cases and the willingness of the participants to use their imaginations and energies to learn.

If role playing is used, the traditional system, in which two people go to the front of the room while everyone else sits and feels smug, should not be used. Dyads, involving groups of two, are preferable. The participants should be given a choice of three cases, usually at different levels of difficulty. Everyone should go to work at the same time. Each person has an audience of one, and each partner both receives and gives "feedback." In a group of 100 with 50 people talking at once, no one has time to worry about how some other set of partners is doing, and the "learning-by-doing" ratio can approach 100 percent.

The fourth and ultimate level is simulation. Properly set up, simulation comes very close to the real thing and handled well offers enormous possibilities for learning. Simulation allows the participants to see what works and what does not work, which is the "bottom line" in any activity.

There is an overall contingency plan written to cover a broad spectrum of crisis situations. Every general contingency plan, however, requires specifics. Regardless of how complete, how thorough, and how descriptive the guidelines in a general plan may be, implementation can only be done adequately at the local level to fit the local situation. Also, every contingency plan needs local job identification.

All plans, both general and specific, work best when thoroughly understood by the Field Response Coordinator in advance. It is very difficult to decipher material, to try to figure out what something means, when the "roof is caving in" and people and events are coming at you from every direction. It is important to be familiar with as much of the plan as possible in advance. In addition, every plan, no matter how well written and complete, needs to be reviewed and updated periodically. People change jobs or responsibilities; the local situation changes. A plan that was exactly what was needed 2 years ago is out of date.

DURING

When the crisis occurs, first it is necessary to get the "facts." Without the facts, the wrong action could be taken or the wrong problem solved. Assuming that the facts have been obtained, and the crisis rehearsal homework has been done, the rehearsed plans can be carried out. Any minor adjustments that the actual situation may require can be made at that time. With these adjustments made, there is time and energy to process new inputs.

Personal behavior during a crisis is extremely important. The attitude taken toward others involved in the crisis can dramatically affect how they react. Running over others roughshod or putting others down may invite retaliation, either directly or indirectly. The words used during emotionally tense situations are more important than those used under normal circumstances. Some people are enraged by certain responses, so that appropriate words should be chosen ahead of time. The tone of voice is sometimes even more important than the actual words used. A sarcastic tone, a belittling tone, and an abrupt brush-off may all be hazardous to your continued health and welfare.

Many authorities believe that at least 50 percent of the message we communicate to others is nonverbal. Jutting the jaw, standing with arms akimbo, turning one's back, looking down one's nose, or giving the "peasants" the message from Washington can create great antagonism.

The person on the listening end may be subjected to a fair amount of verbal "garbage dumping." People may project anger, hostility, and other messages with a high emotional content. When this occurs, one of the key factors in deciding how to respond is how many people are present. If it is a 1-to-1 situation, the "rule of 3" works very well: let people express their emotions, telling their story three times if necessary. This technique allows people to vent their spleen and return to a more normal situation that can be handled rationally. Listen sympathetically and give people a chance to get their temperatures down. While listening, do not inject a "shot of logic," which may make the other person look foolish and may shoot his or her temperature up again. The "rule of 3" works quite well on a 1-to-1 basis, providing that the listener does not develop ulcers.

When many people are present, however, this technique may result in chaos, because of the reinforcement that comes from the presence of other emotionally charged people. In this situation, a calm restating of the viewpoint of the other person, eliminating as much of the inflammatory language as possible, transmits to the person that his/her message has been heard, even though it may not be agreed with. This, in itself, has a healthy effect on most people, because they want at least to be heard. Again a shot of logic at this point may not be well received by people suffering from emotional headaches. Addressing their emotional headaches without making unwise or rash promises, may be advisable at this time.

Even when a crisis situation is handled smoothly, something can happen to upset the balance. That factor is fatigue. Major crisis situations can go on, not just for days, but sometimes for weeks. This means being under stress day after day, possibly without adequate rest and meals. This physical abuse causes fatigue, resulting in behavior that would not occur under normal conditions. Incidently, the more conscientious a person is, the more likely it is that this will happen. Therefore, deliberate steps should be taken to guard against excessive fatigue during crisis situations. It is wise personal management to keep one's body in top operating condition at a time when great demands are being made of it.

During the crisis, manpower and materials most likely will be inadequate to do all that needs to be done. If resources are adequate, either the office is overstaffed or the full extent of the crisis has not been explored. To maximize results, it is necessary to establish a priority system. Sufficient resources must be allotted to the most important activities. This means, of course, dealing with conflicting interests. There will be numerous people who feel that their needs are number one. But all needs cannot be number one, so a judgment of the situation will be necessary.

After priorities have been established, even on the soundest basis, it is possible that a low-priority need may rise to a high-priority need. Therefore, priorities should constantly be reexamined. An item on the priority list may be elevated because of the negative possibilities, even though this activity may not be very important.

AFTER

After the crisis, it is useful to conduct a thorough, critical, and "no-holds barred" post mortem, going into what, when, who, why, where, and how. Understanding what happened this time helps in dealing with the next time and provides the opportunity to change the things that went poorly. A good "after" phase is an investment in the future, because nothing can be done to change what has happened in the past.

As stated earlier, the "before" phase is the most important and the phase in which you should spend your energy. There is one unexpected by-product of crisis management: disciplining of the mind and organizing the thoughts. These very skills can be applied to the smaller personal crisis that occur eventually in almost everyone's life.

PUBLIC AFFAIRS: AN ESSENTIAL INGREDIENT IN POLLUTION RESPONSE

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In 1977, I had the opportunity to make a presentation at the Fish and Wildlife Service Oil Spill Symposium (Fore 1977) in New Orleans on the role of public affairs during an oil spill. I recall, during the question and answer period, being challenged for using the terms "oil spill crisis" and "oil spill catastrophe." I was challenged as spokesman for the Fish and Wildlife Service (FWS) Public Affairs Office for using the terms. I was challenged on technical grounds because the words do not reflect the biological situation. I was not challenged, however, on the media's use of the terms "crisis" and "catastrophe," because these terms describe the way the media have viewed and will continue to initially view significant spills. What is "significant" to the media and to the public may not seem as important to scientists. Public concern about pollution has not abated since New Orleans, and media interest has grown even stronger.

As FWS employees, we need to take advantage of public concern. If we do not make it work for us, we may find it working against us. I would like to point out that the Three-Mile Island incident recently provided us with an excellent example of how public concern should <u>not</u> be handled in a crisis. I like to call it the nuclear revival of Rachel Carson. Let me share with you the concern of one columnist over the events at Three-Mile Island and his view of what the media and the public were told.

The following is from Richard Cohen's column, *Washington Post*, 1 April 1979.

> They lied, they lied, they lied. My God did they lie. They told us it was safe. What a lie. They told us it was clean. Did you every hear such a lie? They told us a lot of things and all week they have been telling us one lie after another. First they vented radioactive something because they wanted to and then they vented it because they didn't want to and now maybe they didn't vent at all. There is only one thing you can count on. They lied.

> Those responsible have the habits of a burglar. In the middle of the night, they dumped 400 thousands gallons of slightly radioactive water into the Susquehanna River. When asked about that and emissions into the air, the company spokesman said, 'I don't know why we need to tell you every step we take, everything we do. A man who tells you nothing cannot be accused of lying.'
>
> A lot of it is not what they said, but what they didn't say. They didn't say they didn't know at all. They acted as if they had it all under control. They were lying.

His accusations are serious and emotional.

The point is that the public was given conflicting information by so many people that in the end, no one believed anything. All felt, rightly or wrongly, that the truth was concealed, that the situation was not under control, and that those in charge did not know what would happen next or what to do about it.

Although the pollution spills with which we are concerned do not approach the human involvement and danger that occurred at Three-Mile Island, this is the type of public reaction that we want to avoid engendering. When you are on the scene at an oil or hazardous substance spill, you and your staff have things to worry about other than what some reporters are going to write in their newspapers. In the heat of the moment, you may regard these news inquiries as a nuisance. But we must remember that the public, through the news media, has a right to know what has happened as quickly as possible. If they do not get the information from you, they will go to someone else, and that source may not be accurate.

It might be just as important for the public to get good information as it is to clean up the pollution. These spills are going to occur, and will draw public attention to fish and wildlife resources. In a democracy, an informed public is essential to the effective functioning of government. In the long run, the public clamor for change will bring about the actions required to protect fish and wildlife endangered by spills. Administrators, then, might view pollution spills in two ways: first, as the ecological problems that they are; second, as an opportunity to emphasize the needs of wildlife resources.

Sometimes when a spill occurs, a defensive "fortress-under-seige" reaction occurs within the responsible agencies, including FWS. We must try to avoid the "us-against-them" mentality and to remember that reporters can be our allies. They give us a chance to get our message across -- to make people more aware of the problems facing fish and wildlife.

To take advantage of these opportunities, we must be responsive to the news media at the spill scene. Also, we, in Public Affairs in the field and in Washington, must know what is going on so that we can respond promptly and accurately to inquiries.

For those of you who are not familiar with the FWS Public Affairs Office, I would like to describe our operation so that you will understand the types of constraints we work under and the types of assistance we can offer you in pollution response.

The Washington Public Affairs Office has three staff groups, all of which could be involved in a given situation. The Current Information Staff deals primarily with the print media. The broadcast media are handled by the Radio and TV Coordination Staff. Often, both operate at the same time and exchange contacts and inquiries. The Audio-Visual Staff handles the logistical support for photography, filming, and possible videotaping of an incident.

We also have Public Affairs Offices in the six Regional Offices and Alaska, whose responsibilities parallel and reinforce those of the Washington Office. These offices generally are staffed by a Public Affairs Officer (PAO) and, in some cases, an Assistant Public Affairs Officer as well. Presently, we have one PAO at an Area Office (Bismarck). We hope to have additional staff at Area Offices soon to add to the professional public affairs capability of FWS as a whole and support for the Service's pollution response in particular.

The Public Affairs Office in Washington also is directly responsible for keeping other facets of the Administration informed. We not only keep the Secretary and his staff abreast of events, but, if needed, call matters to the attention of the White House. The latter happens more frequently than you might think, especially if the President, the Vice President, or the Secretary happens to be traveling to the affected area.

The telephones in the FWS Public Affairs Office in Washington and at the various field offices begin ringing, literally, the minute news of an oil spill or other pollution problem is made public. Calls come in from private conservation groups, news agencies, and individuals eager to help. The public and the news media continue to call until the story of the spill fades to the back section of metropolitan newspapers in the vicinity of the incident.

Imagine us, if you will, far from the spill scene, scrambling around for information to give to CBS, the *New York Times*, and other news media representatives. At the same time, we need to keep information flowing to the Secretary's Public Affairs Office. Because of the demand on us to get news out, we need your cooperation.

Of greater direct impact to you are the television crews and the radio and newspaper reporters who, more often than not, descend upon the FWS spill coordinator on the scene. And this person already has his hands full.

The objective of the Public Affairs function is not only to provide facts to the public, but to relieve unnecessary pressure on the personnel conducting the cleanup operation. If, through the contingency planning procedures, you let us know what is going on, we can handle many of the calls from national television networks, wire services, and newspapers across the country.

In addition, the Washington Office of Public Affairs has worked with the National Pollution Response Coordinator to produce a series of fact sheets in a press information packet. This press packet is designed for use by response teams at pollution spills. It gives the news media and the public general background information on the scope of the spill problem, some of the environmental effects of oil and hazardous substances, and the factors that influence survival rates for oiled birds. We hope that this information will answer some of the questions from reporters or, at least, will provide them with a basis for asking more educated questions. We also believe that it will help prevent the misunderstandings surrounding emotional topics and resulting in questions about why so many birds die or why oiled birds sometimes have to be euthanized.

I will talk now about your public affairs responsibilities during a spill. Not every spill is going to attract media attention. One of your responsibilities is to recognize when you have got a newsworthy spill. As soon as you suspect that you do, make sure that the Regional and the Washington Public Affairs Offices are informed through the contingency plan system. These offices should know whom to contact for additional information and where that person can be reached.

At the scene, one or more team members should devote their time to meeting the needs of news media representatives and the public. Appropriate officers to whom public statements can be attributed should be designated. Periodic statements on behalf of the coordinator, should be released to the media and media representatives should be assisted in obtaining food and lodging. It is most important that the people working with the news media have the support of and access to the operational team leader.

The news media frequently will request information on the long-term effects of a spill. To the extent possible, this information should be provided since many people believe that if wildlife is not affected immediately after a spill occurs, it will not be affected thereafter. The public seldom considers the sublethal effects of oil and hazardous substances or the effects of habitat degradation.

You also will be expected to provide reasonable figures on the confirmed number of wildlife oiled and killed and the species involved. Information on endangered or threatened species found in the area also may be requested.

If the impact of news media and public information requests becomes too heavy for the onsite team, the Public Affairs staff in Washington and at the field level stand ready to deploy people to the site or wherever they may be needed. You should not be reluctant to ask for assistance.

Government personnel should not be concerned with who serves as the "lead agency" in an oil spill situation. Our only concern should be that the public demand for accurate and timely information is met. Agency information, however, should be coordinated. For example, FWS should not comment on why the spill happened, and the U.S. Coast Guard should not comment on estimates of wildlife involved. No matter how tempted you may be to speculate on matters outside your responsibility, as FWS employees, you should restrict your comments to the effects of the spill on fish and wildlife resources.

During major spills, it may be desirable to establish a central source of information on all aspects of the spill. In the case of the *Argo Merchant* oil spill off Cape Cod, the number of different statements from different sources was staggering. We cannot stop self-styled "experts" from making comments to the news media, but we can advise news media representatives through techniques in the contingency plan, that there will be a coordinated flow of information from the scene.

Oil and other forms of land and water pollution have had a major impact on public concern about the environment. The *Torrey Canyons* and the Santa Barbaras of the past and the Three-Mile Islands of the present will maintain a high level of public awareness and concern. Accurate information can prevent distortion of the facts. Timely information can alleviate public concern as well as benefit the pollution response effort and, ultimately, the welfare of our country's fish and wildlife.

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HOW TO EFFECTIVELY USE THE NEWS MEDIA

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The group that I represent, the Public Information Assist Team, was formed approximately 2 years ago. After 9 years the U.S. Coast Guard decided to operate its public information program from the scene of a pollution incident. Up-to-date, accurate information only can be disseminated to all media and the public from the scene of the incident. A public information specialist needs to be on the scene to talk with the agency representatives. Everyone who has worked on a spill knows that if the spill is of any size, things get a little hectic in the beginning. You do not know exactly what needs to be done in order to correct the situation. The On-Scene Coordinators (OSC's) do not have much time to devote to public information. That is why the U.S. Coast Guard tries to promote bringing a public information expert to the scene of the incident immediately, if it appears that the incident is going to be of major size.

My three-person team has responded to at least 10 different incidents. Overall, I am personally out of the office at least half that time. This is because an effective information program in the field can accomplish a great deal, both for that individual incident and for the overall national pollution response program.

Many people in pollution response work have developed negative feelings about media presence or media interests at the scene of an environmental emergency. They look at the media presence and its interest as a disadvantage. Dealing with the media requires time and puts response personnel under a great deal of pressure. However, although it may be a bit inconvenient for the OSC or for the people on the scene to deal with the media, a lot of benefit can be derived when working very closely with the press.

An incident recently happened in Louisville, Kentucky known as the "Valley of the Drums." We were there for 2.5 weeks when the U.S. Environmental Protection Agency (EPA) responded to clean up that area. We had intense media interest, both national, and local. Front page daily news stories ran in the *Courier Journal*, television crews from every local television station were on the scene, plus national media coverage was there. Although it was difficult talking to these news people and explaining to them exactly what kind of situation exists with hazardous materials and the problems that can happen with illegal disposal sites, such as this particular one, media representatives developed a lot of interest in that problem. It received a lot of air time. When you talk about air time, you usually can relate it along with the advertising concept. We have a national problem with hazardous wastes and their disposal. We wanted to talk about the problems of disposing of hazardous wastes to let people know exactly what problems do exist. If we bought advertising time, 1 minute on network television news would probably cost $150,000; however, a 3-minute news spot is totally free.

So when you have the opportunity to constructively use the media to get your message across, do not be afraid to do so. If you want to promote such things as stronger regulations that your agency may be pushing, get it out in the open, talk to the press, express a need for more regulations when talking to them. Say, "Yes, we have a problem with hazardous wastes. If it were oil we would have more money to clean it up. However, at this point in time there is no legislation that allows access to the pollution fund to clean up hazardous wastes. So we are borrowing from our operational funds to do a halfway job." If you explain the situation in detail then you communicate to the media that a problem actually does exist and that something needs to be done about it. That message in turn is communicated in the papers and on national television. Being out of Washington I can assure you that when something is on network news, the next morning some action happens in those offices that have been stagnant for 6 months. Things get done very, very quickly.

Also, you can use the media to contact those people who are directly affected by a pollution incident. If the incident does not merit national attention or have three television crews on the scene all day, it may deserve one or two columns in the daily newspaper. The incident may affect several hundred people quite significantly. If their property is being damaged by oil or if the area they live in is being affected, they become upset.

There are two additional ways to reach people other than through the media. One would be through individual contacts. Publicize the telephone number of the command post. Make it very clear to people that if they have any problems they should contact the OSC and the command post, because they should get the information they need firsthand. They should not rely on secondhand information because it may be inaccurate. If people have problems, they should contact the OSC or his Public Information Officer and get accurate information. It is very important to maintain some level of individual contact while on a spill.

I recall reading a case analysis of the NEPCO 140 and its associated public information problems. After the case, officials tried to determine exactly how the population of that area received its information. Approximately 80 percent of the information about the spill was passed by word-of-mouth. People did not rely on television or newspapers but on other people who went down to the scene to see what was going on, or talked with the people who were cleaning up, or talked with other residents who had been affected. Therefore, if some effort is directed towards individual contact with the people who live in the area that is affected by the spill, fewer problems will result.

The second way of maintaining a localized contact is through governmental officials. One of the first things we do when we arrive on the scene, after we establish emergency telephone service (which takes about 12 hours), and get the telephone numbers out to the media, is to call all the local government representatives. This includes: the fire chief, the police chief, the mayor, local Congressmen and their offices, and the Washington offices of the Senators. We indicate that the U.S. Coast Guard, the EPA, Fish and Wildlife Service (FWS) are all on the scene and there is State representation from the Water Quality Board. We give these government officials the basic information and our local telephone number. We indicate that if they have any problems they should call us and we will try to answer their questions. Or, we offer to give them a tour if they want to come down to the scene. By doing this, people get the idea that you are concerned and are incorporating them into the response effort. Perhaps they feel like they are a little more important.

When we talk with the local officials such as the sheriff, we indicate that the Federal Government is calling him, advising him of what is happening on a daily basis. He then is able to answer the questions that he gets on his normal route during the day. If you try to communicate in this manner, the entire mood of a small community is more cooperative. If you can change this mood from the negative to the positive, you have done a lot. The OSC is going to have a much easier time, fewer phone calls from the public, and you will receive much more good press.

I would like to talk briefly about contingency plans. Any contingency plan should include public information. This is the system that we follow when we arrive on the scene. First, make contact with the telephone company to have telephone lines installed. Then, give the telephone number to AP and UPI in an initial press release. Subsequently, contact the media and the local governmental officials in the area. We try to establish the Federal presence and set up one point of contact for information. Try to avoid having five or six different people talk about one incident. If all the information can flow through one information channel so that the OSC and his Public Information Officer know what is being said, they can correct anything that is said which is inappropriate or not accurate. Try to limit the talking on the scene to the Public Information Officer or the OSC. This does not mean that the U.S. Coast Guard or EPA should not be talking about fish and wildlife problems, not at all. But if the media has a question about fish and wildlife then the Public Information Officer will introduce the FWS representative to the media. The Public Information Officer will listen to what is being said, so if the questions are asked again he can answer them similarly as the FWS representative. That way the same information is going out to everybody and there are no contradictory reports.

I was on a case recently in Crestview, Florida--a train derailment. It was difficult simply because we had a lot of local government participation. We had a local sheriff who wanted to direct the public information and a fire chief who wanted to talk. Anybody the media approached was quite willing to talk. As far as the Federal response, all the information came from the Public Information Officer and the OSC. But, a lot of inaccurate information still was given out. It was inaccurate information which in turn caused multiple problems in Washington, D.C. as well as at the local level. Try to avoid that problem by trying to funnel all the information dissemination to one source who should be located on the scene of the incident.

Anticipate the questions that the press will ask about fish and wildlife. In turn plan your answers. If you are on camera, the newscaster is going to spend about a minute interviewing you and probably will use only 15 seconds of that interview in televised newscast. Anticipate the type of questions so you can give good, accurate, and intelligent responses. If you communicate well, you are going to come across personally looking better. There is a better chance of the media utilizing that information or that tape in its newscast because it is going to make for a better looking newscast when it is aired.

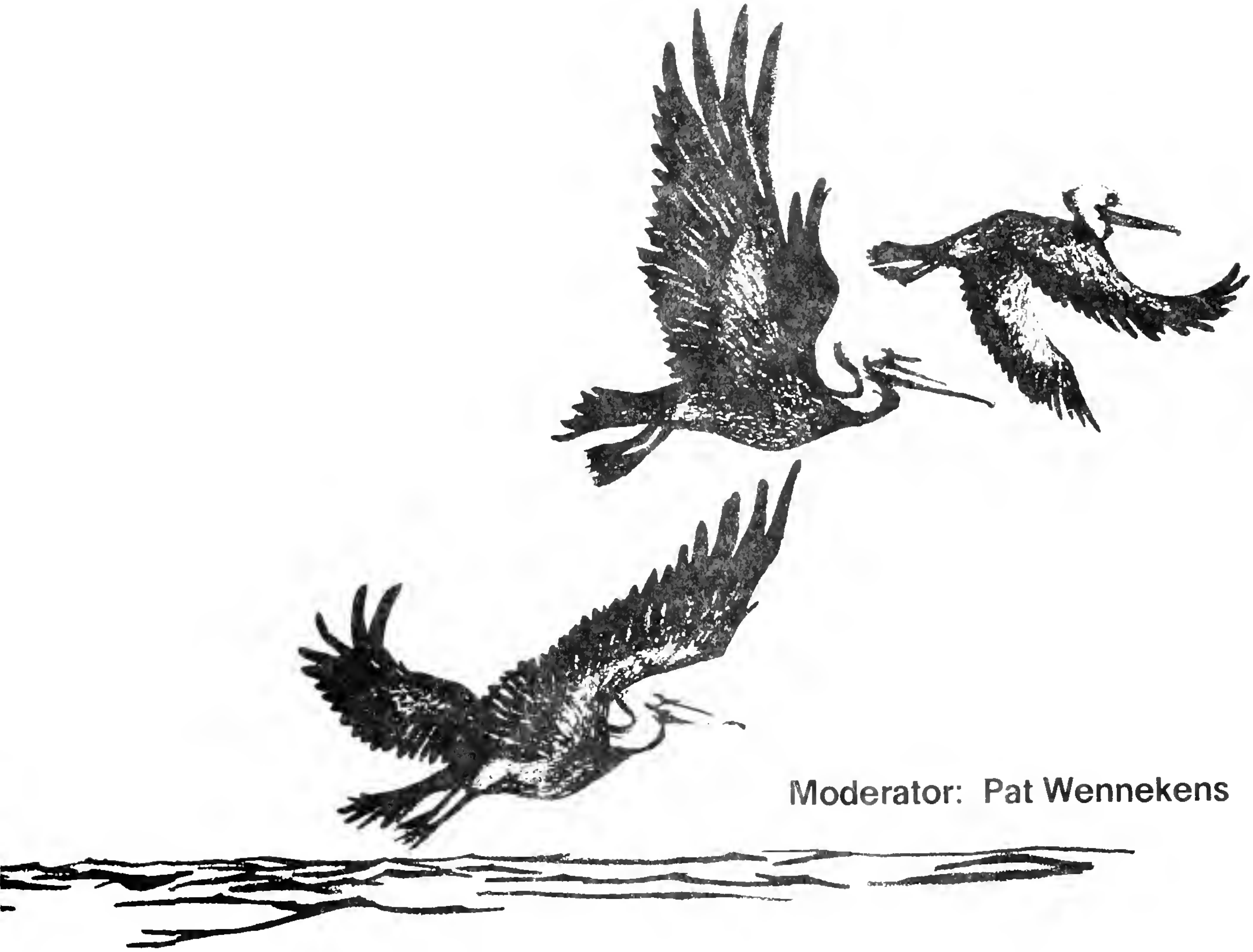
My job is to promote the national program, not to act as a public relations man for the U.S. Coast Guard. Promote the fact that there is a national plan to deal with these things in an emergency situation--something that cuts through the red tape.

I am not sure what you, as FWS representatives should have as your communication objective. Think through what you want to say so when you are asked a question it is very easy to bring up the subject that covers your communication objective. In other words, it allows you to make your point. If you plan what to say before going on camera you have a much better chance of saying it than if you go on without preparation.

Please stick to the facts. As a FWS representative you have a responsibility to maintain the agency's credibility. Do not pass rumors, speculate on issues, or avoid direct answers. Limit your responses to those questions which relate directly to your area of expertise. As I mentioned before, just as the U.S. Coast Guard and EPA should not answer FWS questions, you should not be answering their questions. If you do not know the answer--say so. Indicate that you will find out, or that those data are being collected and are not yet available. This is one of the strengths of the National and Regional Response Team organization. Agency representatives can be found on the scene who can field a variety of questions relating to most, if not all, aspects of a pollution incident.

Another part of public information programs is public education. I feel as though, in running a public relations program, I have a responsibility to inform the public about the problems with oil, chemicals, and their associated transportation problems so citizens are more concerned about the environment. If I can increase the public knowledge of the whole situation, VI

Documentation of Spills and Environmental Damage



Moderator: Pat Wennekens

CONGRESSIONAL PERSPECTIVES ON THE NEED FOR ESTIMATING ENVIRONMENTAL DAMAGE FROM OIL AND HAZARDOUS WASTE SPILLS

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and
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It is a pleasure to take advantage of what is a rather unusual opportunity for Congressional aides. Today's session is unusual in that it represents one of the few instances where we have seen an executive agency make an in-depth, prospective effort to provide technical information which is going to be needed in both the passage and implementation of an important provision in a major piece of legislation. In reviewing the topics of presentations at earlier sessions it becomes apparent that many of the topics covered in earlier sessions also will provide useful insights on the subject of damage assessment. It is certainly our hope that this presentation will give you some insights on why this information is needed in the legislative process and how the information will eventually be used.

As most of you know, damage assessment became an issue last year during Congressional consideration of the proposed Oil Spill Liability and Compensation Act (Superfund bill). The issue first arose because the Senate Environment and Public Works Committee had drafted a Superfund proposal that contained among other things, a provision requiring the development of Federal regulations and protocols for assessment of damage in both oil and hazardous substance spills. The Senate Environment Committee's bill was the only one of the large number of Superfund-type bills which had been introduced either in the House or Senate during the 95th Congress to contain such a damage assessment provision. It is important here also to be aware that the Senate provision included damage assessment of hazardous substances as well as oil spills because of the broader coverage in the Environment Committee's bill. It is significant to note the "coverage issue" since this year there is discussion of including not only damage from oil and hazardous substances spills within the bill, but also damages from abandoned hazardous waste sites, a so-called "ultrafund" bill.

The Committee's bill, S. 2083, was approved by the Senate in the last few weeks of the 95th Congress. What followed then in consideration of S.2083 was a classic example of what happens to legislation when major differences are outstanding in a piece of legislation and collide with end-of-session deadlines -- the legislation died in House-Senate conference. The damage assessment provision in S. 2083, while certainly not the most outstanding area of disagreement, was one of those Sections of the bill in contention between the House and Senate. During House-Senate conference on S. 2083, the House Merchant Marine and Fisheries Committee argued that there was little information on the subject of damage assessment and that the need for such a provision could not be demonstrated. The Senate, while admitting that some problems existed in the scientific and economic methods for damage assessment, held strongly to the conviction that any legislation involving compensation and liability for spills would be both incomplete and inequitable without a provision providing redress where natural resource damage has occurred.

Again this year at Senate Environment Committee hearings concerning liability for abandoned dump sites, the Committee received testimony on the subject of damage assessment and agreed to consider the issue in any liability and compensation legislation it might address in the 96th Congress.

Our prediction then is that most certainly the Senate Environment Committee, and probably the entire Senate, will again approve the damage assessment concept as part of their legislation addressing spills of oil and hazardous materials. Many around the country, including some in this group, might question why such a commitment to the inclusion of a damage assessment process in the Superfund legislation has been made by members of the Senate Environment Committee? The answer to this question is the principle subject of this presentation.

If Congress intends to pass legislation calling for an equitable oil and hazardous liability fund, the need for an implementable damage assessment provision is obvious. If Congress allows damage assessments to be done on an ad hoc basis, as they are now, with no formal procedures or guidelines, inequities in terms of assessed damaged and identified restorative actions will most certainly continue to be the rule rather than the exception. The Senate bill of last year would mandate assessment procedures which would be based on the most current state-of-the-art for assessing natural resource damages.

Where damage to natural resources occurs from oil or hazardous material spills it is most often very difficult to determine what level of response and compensation is required. Here the damaged party is the public. The public may be affected directly such as where a commercial oysterman loses his livelihood due to a spill that destroys his oyster beds -- or indirectly through habitat destruction caused by the spill that ultimately reduces the productivity of the affected area which also results in a damaged fishery.

An effective natural resource damage provision must address both of these situations by assessing both in the most up-to-date fashion possible. In order to make these assessments, several methods of estimating the damages have been proposed. For example, for direct loss of animal life some have estimated the value of purchasing a replacement organism from a biological supply catalog. The problem with this approach is that most of these critters come packed in formaldehyde -- and are not going to do the commercial fisherman who has lost economic livelihood any good.

Knowing how much damage was done and estimating the dollar value of direct losses also has other drawbacks. You can not watch a flock of dollars rising into the sunset on a cool fall day, or taste the subtle flavors of a freshly caught $1 bill (which does not subdue the appetite the way it used to before recent inflation).

Because the assessment techniques just described yield such a poor indication of the true loss, compensation for public losses to natural resources must be based on restoration and replacement of those resources wherever possible. Only through restoration can the true value of the lost resource be made whole. Damage assessment is the key to determining the amount and type of compensation required. It is the foundation for reasonable action to restore public losses. Without adequate and consistent procedures for damage assessment, environmental restoration can never occur. Natural resource damage assessments should accomplish three primary objectives. First, the assessment should clearly describe the type and extent of damage and define actual and potential losses based on those damages. Second, the assessment should describe recommended options for restoration and replacement of the damaged resources, including costs. Finally, where it is determined that restoration and replacement are not feasible, the assessment should develop an estimate of the values lost to society. It is hoped that few situations will fall in the third category.

The most obvious reasons for such codified procedures is to identify and quantify in a comprehensive and systematic way those natural resources damaged in a spill. It may not surprise many here to know that there are currently no standardized protocols for data collection or monitoring of a spill of oil or hazardous materials. This situation, of course, leads to case-by-case determinators that are open to almost endless criticisms.

Another reason for damage assessment procedures is to define the steps one must take to develop a restoration and replacement plan and to analyze the costs of such a plan. Here again standardized procedures should allow for consistency of application and avoid arbitrary decisions in the restoration part of the damage assessment process.

Uniform damage assessment procedures also can assure that all reasonable ecosystem components will be identified in the case of every spill.

Another often ignored factor for support of the regulatory approach to damage assessment during this period of tight government spending and ever increasing inflationary pressures is that this approach allows us to get the most for our money. This is because standardized damage assessment protocols protect against unnecessary expenditures -- either for damage assessment itself or for implementation of restoration plans. This is a worthy goal regardless of the vantage point from which you are considering the issue.

In addition, unnecessary monitoring or inappropriate site specific research could be avoided by use of protocols for damage assessment. For example, when the *Argo Merchant* off the coast of Maine broke up in 1976, the Federal Government spent over $500,000 for field and laboratory work associated with the spill, but because there was no agreed to assessment process we still may have fallen short of providing that basic information necessary in bringing an adequate natural resource damage claim.

Another major benefit of codified damage assessment procedures is that they act as a disincentive to spillers. Certainly, the knowledge of a potential liability for damages to natural resources will act as a disincentive itself, but advance knowledge on the part of a potential spiller of what the total natural resource costs for which he may be liable, may induce a potential spiller to use more care in or to completely avoid areas identified by the regulations as sensitive or having the highest restoration costs. How much such advance notice of potential liability will create a disincentive is, as is the case in many areas of the law, open to question. But the Environment Committee decided that advance notice of fair damage assessment rules not only would provide an extra disincentive, but would in addition be the most fair treatment for both the spiller and the public.

Possibly the most important reason for codified damage assessment procedures is that they provide a standard mechanism for making whole the public for its loss in a spill where natural resource damage is involved. The Environment Committee believed that damages based on direct economic losses of natural resources and the costs necessary for restoration of the damaged resources represents the true loss incurred in a spill and should be used rather than arbitrary penalties that are based on the number of gallons spilled or some other artificial measure.

There are many examples of where such ad hoc assessments have failed to adequately estimate or compensate for such losses. In 1972 a Steuart Transportation Company barge sank in the Chesapeake Bay spilling 250,000 gallons of No. 6 fuel oil. Damages were estimated at $1,330,000. This included cleanup costs of $610,000, the value of the spilled oil at $80,000, and the value of the waterfowl killed estimated to be $640,000. The estimate of the number of waterfowl killed and the method for determining their value was subsequently questioned.

Everyone agreed that the waterfowl were valuable, but a dispute over the best process for computing this valuation resulted in the discounting of this entire area of damage from the final assessment. While the Committee realized that arguments on how best to complete a damage assessment will go on for years, it decided that there must be at present a best technique for making such judgments and that this should be used to avoid the obvious inequities such as those in the Chesapeake spill just described.

The Senate bill would mandate after a formal regulatory review process the use of such a "best" procedure until a more reliable one is discovered and can be incorporated into the regulations for damage assessment. In other words, the approach used in the bill calls on the Federal agencies involved to make a judgment on what the best state-of-the-art procedure is and then mandates its use in damage assessments until something better is discovered. This certainly seems preferable to trying to work with a different damage assessment procedure in each individual spill.

It should also be noted that in the Chesapeake spill, mentioned previously, not just waterfowl were affected -- 27 miles of wetlands were oiled, many invertebrates were killed, and extensive oiling of oyster beds occurred. Because no established procedures existed to estimate the restoration or replacement costs or value of these natural resources losses -- again no damages were assessed.

A significant mortality rate for oysters was found in the oiled area 4 years later. Who compensated the oystermen for these losses? No one! If damage assessment procedures were available that required restoration of damaged resources where such resources were replaceable then the unquantifiable cost might be avoided. The Committee believed it was reasonable to expect a spiller to help restore a damaged area where techniques were available to make it possible.

In summary then, the theory behind any Superfund legislation should be to provide a response to spills of oil and hazardous materials which makes full compensation to damaged parties in cases where the responsible party is unable to do so.

We hope that this brief discussion has provided you with some insight into the reasons why the Senate Environment and Public Works Committee included provisions for damage assessment regulations in S. 2083. We predict that you may be seeing similar provisions again in the future legislative efforts by our Committee and trust that many of you in this group will be involved in both the creation of and implementation of the damage assessment provision that is ultimately approved by our Committee and the Congress.

ESTIMATING ENVIRONMENTAL DAMAGE

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INTRODUCTION

Information Base

The problem that has existed with almost all oil and hazardous substances spills is the scarcity of data on:

1. Environmental concentration--the actual or predicted concentrations resulting from pollution sources as modified by the biological, physical, and chemical processes acting on the chemical or its weathered products in the environment; and

2. The threshold concentration of the substance at which there is no adverse biological effect.

This information is usually generated by chemical engineers and biochemists. Both kinds of information are badly needed in order to effect the cleanup and restoration that have been discussed at this workshop. And the information base must be far, far larger than any we have gathered in the past.

The following statistics illustrate the magnitude of the problem of hazard assessment for chemicals. Over 4 million entities are registered in the American Chemical Society's computer registry of chemicals. In addition, there are approximately 6,000 new entities being produced in the United States annually. It is obvious that the resources, in terms of funds and qualified personnel, are inadequate to perform the laboratory work required to gather all the information needed on each chemical.

Identifying High-Priority Chemicals

The first thing that should be established is a priority matrix to determine the chemical substances that deserve the highest priority for testing. Table 1 shows such an illustrative matrix.

Table 1. Determination of Priority for Testing[a]

Predictability of toxicological characteristics of chemical substance	High (1)	Medium (2)	Low (3)[b]
Widespread distribution (4), substantial amounts released	4	8	12
Widespread distribution (3), small amounts released	3	6	9
Localized distribution (2), substantial amounts released	2	4	6
Localized distribution (1), small amounts released	1	2	3

[a]To determine final priority number, multiply the appropriate number above by the following vulnerability factor for the receiving system: high = 3, medium = 2, low = 1, (From an approach for determining priority testing in Principles for Evaluating Chemicals in the Environment, National Academy of Sciences, Washington, DC 1975, 453 pp.)

[b]High number indicates high priority.

The matrix is designed to determine relative priorities within a single decisionmaking area. For simplicity, the number of categories has been kept to a minimum. For maximum safety, it would be well to use a slightly higher than probable consideration of impact in making all the decisions. Furthermore, because of the simplicity of the matrix, it should be used only as a guide rather than as an absolute and rigid system of priority determination. Specific problems related to a particular chemical, region, or ecosystem must be introduced by the user. Failure to do so will almost certainly result in an inadequate definition of the problem.

In Principles for Evaluating Chemicals in the Environment, the presumption is that the biological effect of linear alkyl sulfonates or other detergents is minimal, but the effect of chlorinated hydrocarbons and other fat-soluble materials is very severe. The approach is coupled with a materials-balance analysis so that one can distinguish between certain chemicals used in small amounts in very small regions and chemicals used in large amounts globally. By combining the materials-balance information for a chemical with biological-effects information, it is possible to obtain a number that indicates relative priority in conducting a hazard evaluation of the chemical.

Inertia and Elasticity

Two important characteristics of an ecosystem receiving oil or other hazardous substances are its inertia and its elasticity. Inertia is its resistance to change, or how much it can be stressed before it will change. Elasticity is its ability to snap back to an approximation of the original condition after major disruption from pollutional stress. This second characteristic is of particular importance in spill response. These components are difficult to quantify, but some estimates can be made.

The critical factors contributing to rapid recovery of damaged ecosystems are as follows:

1. The existence of nearby epicenters for providing "seed" organisms to reinvade a damaged system (e.g., for a river these might be tributaries).

2. Mobility of life stages that may be important to movement of the species. These may be spores, eggs, larvae, flying adults that lay eggs, or any other stage in the life history of an organism that is capable of moving either actively or passively to a new area.

3. Condition of the habitat following pollutional stress.

4. Presence of residual toxicants following pollutional stress.

5. Physicochemical quality of the environment following pollutional stress.

6. Management or organizational capabilities for immediate and direct control of the damaged area.

Factors 3 through 5 are less important in this situation because it does no good for the organisms to reinvade if they cannot survive once they do so.

The presence of some regional management capabilities should be discussed. In a paper "Opportunities for Maintenance and Rehabilitation of Riparian Habitats," data on two streams located in different drainage basins in Pennsylvania were used to show that by using only fish as an indicator, one can calculate the time it would take an ecosystem to snap back and the difficulty of this process. Enough case histories exist to document the efficacy of this process although the components are difficult to quantify.

The other property of the ecosystem is inertia, or the ability to resist change. The fact is that indigenous organisms accustomed to naturally fluctuating environments are much more resistant to change than those adapted to stable environments. Structural and functional redundancy is the familiar "spreading the risks" concept: if several organisms perform the same function and one is lost, the system suffers less than if only one organism is performing a job and is lost. This is discussed at length in Cairns et al. (1979). Chemical characteristics are important in estimating inertia. In aquatic systems, hard water antagonizes heavy metals. For example, the Guadalupe River in Texas will tolerate roughly four times as much zinc as an eastern coastal stream before reaching a toxic threshold. The Texas stream has approximately 300 parts per million (ppm) of calcium whereas the eastern stream has about 30 ppm of calcium. Another characteristic important in estimates of inertia is the proximity to an ecological threshold. This is easy to describe but difficult to document. It is known that ecological thresholds exist for temperature, pH, and so forth, but these limits are hard to establish. However, an attempt must be made to do so. I believe we can calculate an ecosystem's inertia as well as its elasticity, and substantial evidence exists to make these estimations (Cairns et al. 1979).

HAZARD ASSESSMENT

With 6,000 new chemicals being developed each year, it is impossible to conduct hazard assessment tests on every chemical. Further, it is known that certain environmental situations require more assessment information than others. So, the problem is how do we know when we have enough information to make a management decision?

The process of hazard assessment is shown graphically in Figure 1. Tier 1 is a "dropdead" batch bioassay that is crude, simple, and costs, approximately $300 to $1,000. Tier 2 is a continuous-flow, more sophisticated and expensive bioassay, and Tier 3 even more so, perhaps a life cycle bioassay that might cost as much as a hundred thousand dollars. Two important pieces of information are to be determined for the evaluation. The first is the environmental concentration of the chemical in question, which depends on the amount of the release, on the dispersion, and on the properties of the specific chemical, such as how it partitions, its volatility, and its stability. For instance, a linear alkyl sulfonate degrades rapidly; a chlorinated hydrocarbon does not. The second type of information is the concentration of the chemical that does not cause adverse biological effects. There is great uncertainty about this concentration for most chemicals. However, methods are available for making these determinations.

In Figure 1 the horizontal solid lines are the concentration of a chemical that produces no adverse biological effects and the actual environmental concentration of the chemical. The dotted lines around the solid lines in the figure indicate the uncertainty associated with these numbers at each level of testing. Uncertainty decreases with more testing, but it is never reduced to zero, because testing can only involve a few of the many organisms that are being protected. As a consequence, results are being projected from a few organisms to a large community.

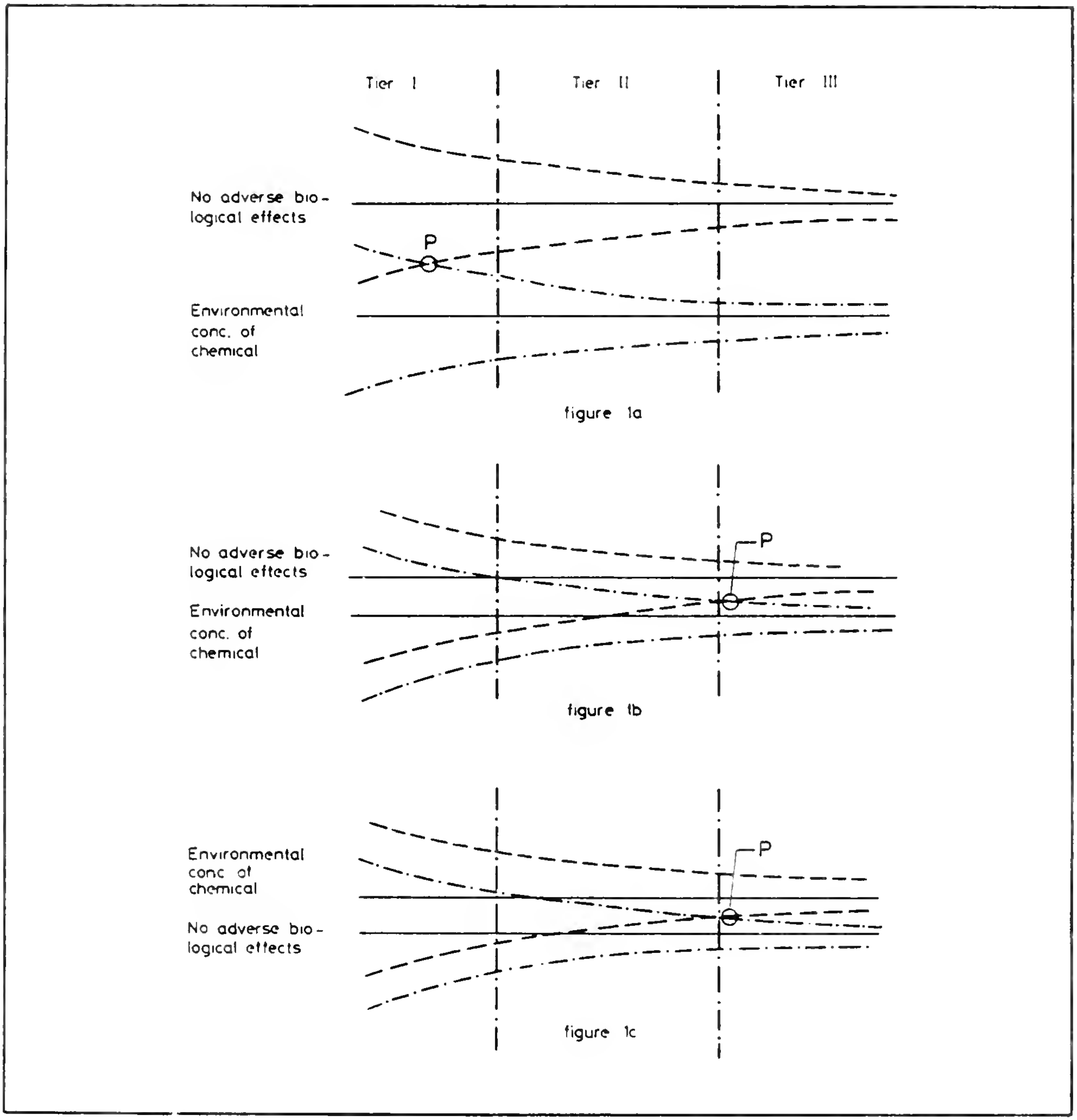

Figure 1. Relationship of a chemical concentration that produces no adverse biological effects with the actual environmental concentration of the chemical. Tier I bioassays of toxicity tests are preliminary or screening tests; those in Tier II are of intermediate complexity; and those in Tier III are the expensive long-term, sophisticated tests for sublethal responses. P indicates the point in the testing program where a decision is justified. Reprinted with permission from the American Fisheries Society as printed in J. Cairns Jr. 1978. Hazard evaluation. Fisheries 3(2): 2-4.

In order to make a sound decision, it is necessary to know whether the environmental concentration is indeed below the "no adverse effects" concentration. In Figure 1a the environmental concentration is well below the no adverse effects concentration and a modest amount of "testing," corresponding to the point P, shows that there is no overlap in uncertainty. At a reasonable risk, therefore, the chemical can be produced and used.

In the next case (Figure 1b) the two concentrations have a similar relationship: the environmental concentration is lower than the "no adverse biological effects" concentration. However, because the two concentrations are so close, one must continue to Tier 3 testing before making the same decision as in Figure 1a and with the same degree of confidence. This method, coupled with the priority matrix, is one way to determine how many tests are necessary to make a reasonable judgment as to when one can use a chemical with relatively low risk. In other words, this approach helps to determine how broad the information base needs to be.

The 1976 Toxic Substances Control Act states that evidence shall be provided for all new chemicals regarding their hazard to human health and environment. This includes the extraction, manufacture, transportation, and disposal of such chemicals. The ruling also applies to existing chemicals that are being used for a new purpose. In Figure 1c continued testing shows that the environmental level is above the "no adverse effects" level with the same degree of confidence. In this case, the Administrator of the Environmental Protection Agency would be required to either ban or restrict the use of the chemical. A cost-benefit analysis is then warranted to ascertain whether the benefits to society are greater than the environmental damage associated with the use of the chemical.

A strategy exists for proceeding through the three tiers of protocols It is derived from a study for the Army Medical Command on hazard assessment related to effluents from Army ammunition plants (Cairns and Dickson 1978). The philosophy underlying protocols is discussed in the book, Estimating the Hazard of Chemical Substances to Aquatic Life (Cairns et al. 1978). Another book is in press (Dickson et al.) that incorporates many of the protocols used by industrial societies worldwide, including Japan and Germany. Although the details are different, the strategy used in each country is the same. It is interesting to note that each country developed its protocols without much awareness of the other countries' efforts.

The basic protocol strategy consists of concurrent laboratory and field studies (Figures 2 and 3). Beginning with a broad trophic-level base of organisms such as algae, invertebrates, and fish, it identifies the most sensitive of these trophic levels with the inexpensive tests. The increasingly expensive, difficult, and sophisticated tests are conducted only on the most sensitive component in the trophic level system. Decisions are alternated with data-gathering, using an increasing focus on what is, on the basis of the evidence collected, the most sensitive link in the chain.

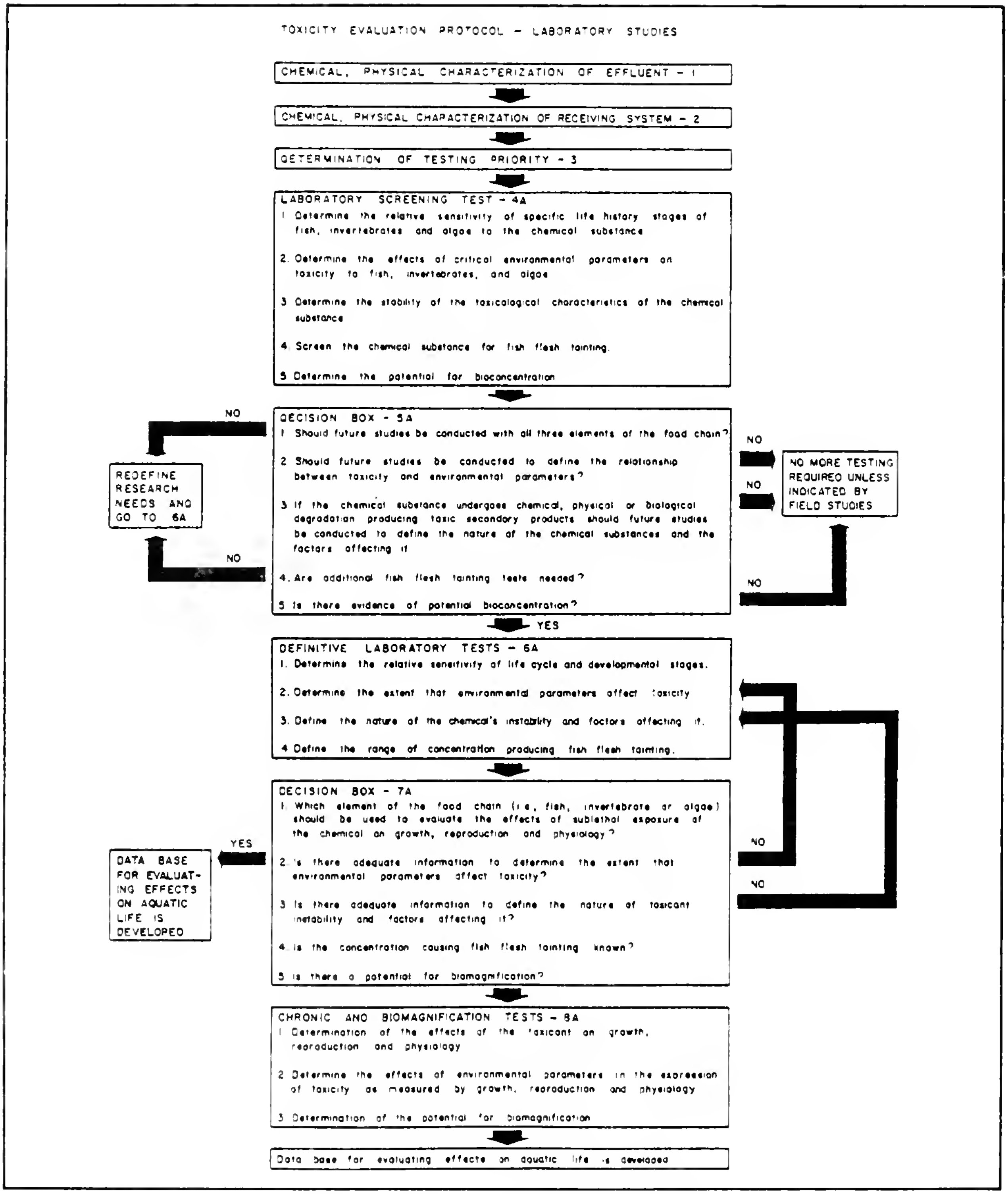

Figure 2. Toxicity evaluation protocol--laboratory studies. Reprinted with permission from the American American Society for Testing and Materials as printed in the J. Cairns Jr. and K.L. Dickson. 1978. Field and laboratory protocols for evaluating effects of potentially toxic wastes on aquatic life. J. of Testing and Evaluation 6(2): 85-94. Copyright ASTM.

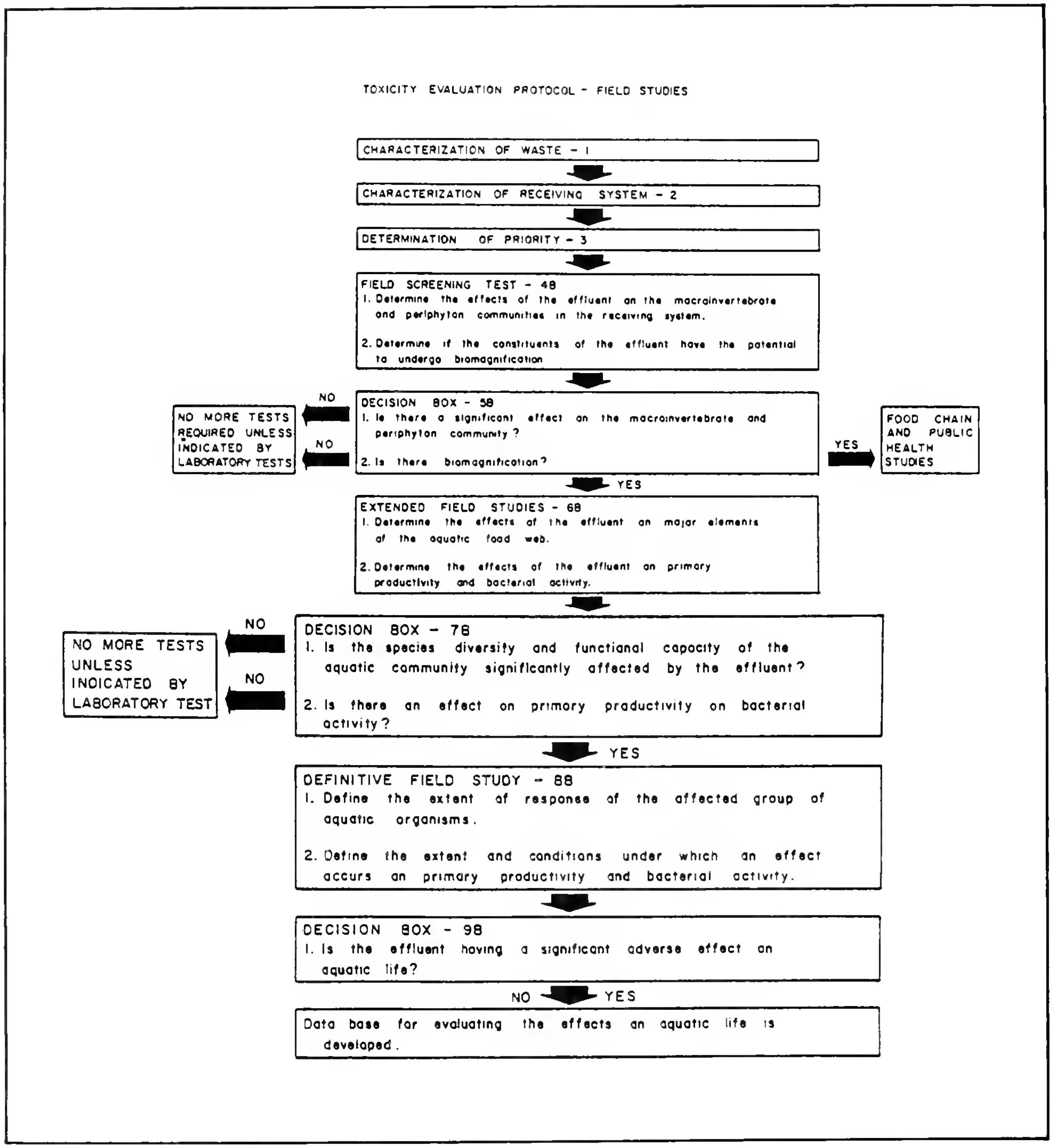

Figure 3. Toxicity evaluation protocol--field studies. Reprinted with permission from the American Society for Testing and Materials as printed in J. Cairns Jr. and K.L. Dickson. 1978. Field and laboratory protocols for evaluating effects of potentially toxic wastes on aquatic life. J. of Testing and Evaluation 6(2): 85-94. Copyright ASTM.

In Figures 2 and 3, the chemical and physical characterization of the chemical or effluent (Box 1) includes information on: rate of degradation, absorption to colloidal materials, and combination (e.g., chlorine with amines to produce chloramines). The chemical and physical characterization of the receiving system (Box 2) includes: likelihood that the system will be displaced; and probability of recovery once the system is displaced (inertia and elasticity). Some ecosystems, of course, are perturbation-dependent, for example, the fire-dependent ecosystem in California.

The third element of the evaluation protocol (Box 3), the determination of testing priority, involved identifying the chemicals or other stressors that deserve the most attention and the most detailed and sophisticated information base. During the laboratory screening tests in (Box 4), it is first determined which of the trophic levels are most sensitive, and the effects of environmental parameters on the response to a toxic compound.

In the definitive laboratory tests (Box 6), one determines which is the most sensitive life-history stage, because most commonly only one life-history stage is used for the various organisms tested in Box 4. Then, the extent that environmental parameters affect toxicity is determined. Third, how stable is the material in terms of its toxicological characteristics? Does it degrade rapidly or is it highly persistent? Four, does the substance produce flavor impairment, making it toxicologically safe but esthetically objectionable? Finally (Box 8), the potential for bioconcentration must be defined.

CONCLUSION

The questions that society might reasonably ask of biologists dealing with the problem of hazard evaluation follow:

1. What changes signal ecological degradation or harm to a species?

2. What is the best established and most widely accepted method for measuring each of these?

3. Who is professionally qualified to make these measurements?

Some progress is being made but it is far short of the need. It is worth noting that the American Fisheries Society's certification program was an enlightened step toward meeting the third of these needs.

As a profession, biologists have been asking society to stop polluting water ecosystems. We have emphasized the magnitude and importance of the problem. Now society has indicated that it cares and wants to know how to resolve the problem. The professions that called attention to pollution are now being asked to provide the methods and protocols for ecosystem quality control and hazard evaluation. More research is almost always useful, but the most pressing need is effective use of existing methods by qualified persons. The profession of biology and its components, such as fisheries, must make major adjustments to meet the needs of hazard evaluation. If professional societies do not meet this need, other organizations will.

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ANALYTICAL DOCUMENTATION OF SPILLS OF OIL AND HAZARDOUS SUBSTANCES INTO THE MARINE ENVIRONMENT

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INTRODUCTION

In the Clean Water Act of 1977, which is still the primary Federal law governing spills of oil and hazardous substances, Congress declared that the discharger is strictly liable for a limited amount of the actual cost of clean-up incurred by the United States (Fideli and DuBey 1978). What is significant about this particular environmental law is that for the first time the cleanup costs included not only the cost of removal of the spilled substance but also any expenses incurred by the Federal or State Governments in the restoration and/or replacement of natural resources damaged by the spill. Even though this law removed the necessity of proving negligence to establish liability, the Federal and State Governments still must prove causation and establish valuation. That is, they as claimants have to assess any environmental damage that was caused by the spill, and then assign a dollar value to offset the cleanup and restoration costs.

The need to assess environmental damage coupled with the likelihood that the scientific data gathered during the assessment process will eventually be used in court has affected, and will continue to affect, how spills of oil and hazardous substances are handled. It is true that accurate documentations of valid scientific observations lend themselves to use as legal evidence but it is not always true that good science makes good law. For instance, few laboratories would routinely establish a "chain of custody" for samples brought in for analysis if the data generated from those samples were not to be used in litigation.

In this paper we will address the problem of analytical documentation of spills in a manner that is both scientifically valid and legally acceptable. Since there are numerous analytical methods that can be employed at any particular spill, few references will be made to specific analytical techniques. It is hoped that the general documentation procedures and sample handling techniques described will be applicable to most, if not all, analytical techniques currently in use.

The analytical documentation scheme presented herein is not intended to be the definitive work on the analytical investigation of a spill. It is, however, presented as a stand-alone analytical documentation procedure that can be and should be coordinated with biological documentation procedures so that samples taken for chemical analysis are of equal status with those taken for biological analysis.

THE ANALYTICAL DOCUMENTATION PROCEDURE

A procedure encompassing the major requirements for analytical documentation of a spill is presented in Table 1. In Phase I of the documentation scheme, the spill area and a control area are sampled in detail immediately after the spill. Sampling during this period of acute or short-term impact should continue for about 1 or 2 weeks. In Phase II the spill and control areas are sampled in a limited, selective fashion. This sampling period, which covers the period of chronic or long-term impact, could last from 1 to 5 or more years. The rationale for this documentation procedure follows.

Table 1. Analytical Documentation Procedure

A. Phase I. Acute or short-term impact

   1. Detailed qualitative analysis of the spilled substance in various forms.

      a) neat
      b) weathered
      c) water-soluble fraction

   2. Detailed qualitative analysis of the spilled substance extracted from environmental samples.

   3. Quantitative analysis of control samples representative of each sample type collected.

   4. Quantitative analysis of samples to delineate the extent of the spill.

      a) in the physical environment
      b) in the food web
      c) in highly visible organisms

B. Phase II. Chronic or long-term impact

   1. Quantitative analysis of a limited number of serially collected samples from the spill area and a control area.

      a) sediment
      b) sessile benthic organism(s)

Phase I -- Period of Acute or Short-Term Impact
Detailed Qualitative Analysis of the
Spilled Substance in Various Forms

A detailed analysis of various forms of the spilled substance is required primarily to aid in identifying the discharged material in environmental samples.

Analysis of the neat or unaltered substance would provide data for making or confirming an initial identification of the discharge. This analysis would also furnish information on the relative concentrations of various components of the discharged material prior to weathering.

Analysis of the weathered form of the spilled substance is required because it is usually the weathered form of the discharged material that is encountered by organisms in the environment.

If the spilled substance is not miscible with water, an analysis of its water-soluble fraction should be done. The discharged substance should be partitioned against uncontaminated water made up to a suitable salinity, and the fraction extracted by the water analyzed. Data from this analysis would be of particular value when analyzing water-column samples and organisms collected from the water column.

Detailed Qualitative Analysis of the Spilled
Substance Extracted from Environmental Samples

Detailed analyses of selected environmental samples, to include both biological samples and ones from the physical environment, should be carried out to positively identify the source of the discharged contaminant. The discharger could be in essence "fingerprinted" by a comparison of data from analyses of environmental samples with data from analyses of the spilled substance taken from the suspected source.

Quantitative Analysis of Control Samples
Representative of Every Sample Type Collected

Control samples representative of every sample type must be collected and analyzed to establish background levels of the spilled substance already present in the environment. Since it is unlikely that prespill concentration data will be available, baseline levels of the spilled substance detected in the control samples must be subtracted from samples taken at impacted areas to determine net increases in the concentration of the spilled substance.

Quantitative Analysis of Samples
Delineating the Extent of the Spill

Early analytical delineation of the spill in both the physical environment and the food web is required to define the extent of the ecosystem impacted by the spill.

The physical environment should be sampled both vertically and horizontally. Vertical sampling should include samples from the sediment, the water column, the water surface, and if the spill is particularly large or the spilled substance particularly volatile, the atmosphere. Horizontal sampling should be carried out in such a manner that concentration gradients of the spilled substance could be established.

Sampling of the food web should include samples of benthic organisms, plankton, fish, and higher carnivores when appropriate. At least one group of sessile benthic organisms such as mussels or oysters should be sampled during the period of acute or short-term spill impact.

Even though such a procedure may be of questionable scientific value, it is advisable to analyze the tissues of highly visible organisms such as waterfowl and fish whose carcasses often wash ashore following a spill. The deaths of such organisms usually have a disproportionately large psychological impact on the public. Analytical data verifying that the spilled substance is in the tissues of such organisms can be of considerable value to an attorney.

Phase II -- Period of Chronic or Long-Term Impact
Analysis of a Limited Number of Serially Collected Samples from the Spill Site

Analytical documentation of the persistence of the spilled substance in the physical environment and the food web is necessary to assess the chronic or long-term effects of the spill.

For this type of documentation serial samples should be taken over a period of time, usually measured in years. Samples should be collected at close intervals immediately after the spill, then less frequently as time progresses. No fewer than four samples should be taken per year. This number is based upon the assumption that biologists would continue their assessment of chronic environmental impacts by sampling spill site biota during each of the four seasons. Analysis of serial samples would also document the weathering processes undergone by the spilled substance under the actual environmental conditions encountered after the spill. Such documentation lends credence to identifications of severely weathered forms of the discharged material in environmental samples made months or even years after the spill.

The initial set of samples taken to determine persistence of the spilled substance in the environment should, ideally, include every sample type (not every sample) collected for delineation of the spill in Phase I. Then, as the concentration of the spilled substance returns to the control level in any particular sample type, that sample type is dropped from the next sampling cycle. In all but the most severe spills, this will occur very quickly for most water-column and biotic samples. Indeed, the spilled substance will probably persist longest in sediments, which are proven sinks for many organic (Farrington and Tripp 1977) and inorganic (Bryan 1976) pollutants, and in benthic organisms, such as mussels and oysters (Stegman and Teal 1973).

LEGAL ASPECTS OF ANALYTICAL DOCUMENTATION

The legal elements that must be proven to attach liability to a specific discharger (Dunnigan 1978) are listed in Table 2. It is apparent that data derived from the analytical documentation procedure described previously would be useful in proving a number of the required legal elements. For instance, analytical data could be used to establish that a spill occurred, although photographic documentation and eyewitness accounts would be more useful. Analytical data used to "fingerprint" the spilled substance would undoubtedly be influential in establishing that a specific discharger caused the spill, if the discharger contested his liability. Unfortunately, it does not appear that analytical data will help to establish the validity of what is probably the most difficult legal element to prove, which is, that the spill actually did do significant damage to the environment. This statement relates primarily to damage done to populations or communities. Many forms of acute short-term environmental damage, such as fish kills and kills of waterfowl are easily detected. Even though such observations are easily made, however; it is difficult to estimate the effects of the kills at the population or community levels. For instance, who really knows what percentage of a fish kill is represented by the carcasses that wash ashore? As suggested by this observation, it is much more difficult to prove that a population or community was damaged than that an individual organism was damaged.

Table 2. Legal Elements that Must be Proven to Attach Liability (Dunnigan 1978)

1. The spill occurred
2. A specific discharger caused the spill
3. There was environmental damage
4. The spill caused the environmental damage
5. The cost of cleanup and restoration and/or replacement of natural resources

There is as yet no universally accepted method for determining that a particular population or community was damaged by a spill. It seems likely, however, that regardless of what population parameters are measured, the biologist must establish that the: (1) system of interest changed following the spill, (2) magnitude of the change was greater than expected based on estimates of the normal variation of the system, and (3) change actually represented damage to the system. Point number one, that the system changed, can usually be determined empirically, and point number three, that the change actually represented damage to the system, will probably be established in court through arguments based on expert opinion. Point number two, that the change was greater than could be explained by the normal variation of the system, is the most difficult to prove. Since the availability of prespill biological data is unlikely, the best estimate of the normal variation of the impacted system will probably be obtained after the spill from measurements taken on a similar, unimpacted control system. Once some estimate of the normal variation of the impacted population or community system is obtained the significance of the observed postspill changes in that population or community can be determined. Significant alterations of both populations and communities may occur as short-term and/or long-term effects of a spill. Unfortunately, present state-of-the-art monitoring techniques are inadequate for separation of ecosystem perturbations brought about by natural processes from all but the most obvious effects of spill incidents (Topping 1976). The emphasis placed on assessment of environmental damage by the Clean Water Act of 1977 should stimulate needed research in this area.

Returning to the legal aspects of analytical documentation, analytical data derived from a spill would be significant in establishing causation, this is, that the spilled substance actually did cause the environmental damage ascribed to the spill. Good arguments can be made that a particular spill caused a particular set of environmental perturbations based only on the temporal and spatial relationships between the spill and the environmental perturbations. Placing the spilled substance in the tissues of dead organisms collected at the spill site, however, would establish a direct link between the spill and the observed damage.

It is unlikely that analytical data will be influential in establishing the cost of cleanup and restoration of the natural resources. If estimates of plankton and pelagic organism kills based on evaluation of laboratory bioassay data, field survey data, and quantitative analytical (water column) data (Hirota et al. 1977) prove to be legally acceptable, this situation would, of course, change somewhat. The cost of cleanup and restoration and/or replacement of damaged resources should be assessed by teams of biologists and economists utilizing all pertinent information. The courts, however, will probably make the ulitmate determination of the costs of cleanup and restoration to the discharger.

CHAIN OF CUSTODY

Availability of a "chain of custody" for samples taken at a spill site is particularly important to an attorney trying to establish that the samples were analyzed in as near their original state as possible. A "chain of custody" is simply a documentation of the general rule that spill site samples should always be either under observation or locked up. Samples taken for documentation of a spill should be labeled according to accepted scientific procedures as they are collected in the field. In addition, the taking of each documentation sample should also be witnessed by a second person. Thereafter, every time that the sample changes hands a record of the transfer should be kept both on a custody tag attached to the sample itself and in a comprehensive set of sample records maintained by the party coordinating the documentation efforts. The comprehensive record set should indicate who has custody of every sample at all times.

Whatever the design of the chain of custody tag, it should be made of waterproof material and all entries on the tag should be made in ink that will not smear when dampened. The mailing address and telephone number of the collecting organization should appear on the custody tag, and the tag should be arranged so that it can easily be filled out in the field.

The tag presented in Figure 1 functions as both a sample identification tag and as a chain of custody tag. If this tag is filled in correctly it will satisfy the scientific and legal requirements for sample verification, and also the legal requirements for establishment of a chain of custody. A brief explanation of each of the entries on the sample tag depicted in Figure 1 follows.

Sample Identification Tag

Tag No: As a means of associating a particular group of samples with a particular spill, each spill should be assigned a unique set of tag numbers.

Sample No: Once a sample number is assigned all further references to that sample in field notebooks, laboratory notebooks, and elsewhere should be prefaced by its sample number.

Time: The approximate time that the sample was taken should be recorded.

Date: The date that the sample was taken should be recorded.

Sample Description: The sample description should be brief and concise.

Preservative Used: The preservative used and the recommended method of sample storage should be recorded.

Collected By: The signature of the person who actually collected the sample along with his or her address and affiliation, if different than that of the organization charged with collecting the samples, should be recorded.

Witnessed By: The signature of the person who witnesses the actual taking of the sample along with his address and affiliation should be recorded.

Remarks: A brief description of the sampling site and the sampling station number should be recorded.

Sample Chain of Custody

Received From: The initials of the person from whom the sample was received and his or her affiliation should be recorded.

Received By: The initials of the person receiving the sample and his or her affiliation should be recorded.

Date: The date of the sample transfer should be recorded.

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UNIVERSITY OF NEW ORLEANS
NEW ORLEANS, LA. 70122

IF FOUND CALL 504-283-0844

TAG NO. ____________________ SAMPLE NO. __________

TIME: ____________________ DATE: __________

SAMPLE DESCRIPTION: ____________________

____

PRESERVATIVE USED: ____________________

COLLECTED BY: WITNESSED BY:

______________ ______________

____

REMARKS: ____________________

SAMPLE IDENTIFICATION TAG

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UNIVERSITY OF NEW ORLEANS
NEW ORLEANS, LA. 70122

SAMPLE CHAIN OF CUSTODY

TAG NO. ____________________ SAMPLE NO. __________

RECEIVED FROM:	RECEIVED BY:	DATE:	DISPOSITION:
1.			
2.			
3.			
4.			
5.			

Figure 1. An example of a sample chain of custody tag that also functions as a sample identification tag.

Disposition: A brief indication of the condition of the sample at disposition, such as intact or not intact, should be recorded in the presence of the courier by the person receiving the sample.

More complete information on sample condition at disposition should be included in the laboratory notebook of the receiver if the sample is not intact when it arrives. The means by which the sample was transported should also appear in the notebooks of both the sender and the receiver. When possible, samples collected for spill documentation should be transported by special courier, however; transport by means of registered mail, with a return receipt requested, is also acceptable (40 U.S.C. 1977).

SAMPLING STRATEGY

Sampling strategy is particularly important to analytical spill documentation because analytical data can be no better than the samples from which they are derived. The analytical laboratory charged with documentation of the discharge should, therefore, participate directly in selecting and executing an appropriate sampling strategy.

The selection of a sampling strategy for a specific spill site should be based primarily on the chemical characteristics of the spilled substance, the physical environment of the spill, and the resources available for sampling. For maximum utilization of the analytical data it is imperative that the sampling strategy selected for analytical documentation be coordinated with other aspects of the spill investigation. For instance, a set of samples for chemical analysis should always be taken concurrently with each set of biological samples. The conditions at a spill site often change so rapidly that unless biological and chemical samples are collected simultaneously, it may be impossible to correlate the analytical data with the biological data during the final assessment process.

Where to Sample

Even in a small spill the number of habitats, i.e., salt marshes, sandy beaches, intertidal mud flats, etc., that are impacted can be prohibitive of sampling each habitat. Ideally, at least one of each type of impacted habitat should be sampled. In actual practice, however, the limitations imposed by availability of resources usually results in habitats being sampled on the basis of priority. The priority of each impacted habitat should be based primarily on an evaluation of its ecological, commercial, and esthetic values. Although such priority systems will vary from spill to spill due to the unique characteristics of each spill incident, it is possible to start with a generalized habitat priority sampling list. For this purpose, a series of habitats is listed in Table 3 in decreasing order of sampling priority. This ranking is based on the ecological value of the habitat and on the potential ability of the habitat to cleanse itself following a spill incident. The high-energy systems, with their greater wave action and generally stronger currents, have a much better potential for self cleaning than the low-energy systems. Other types of habitats, such as critical habitats of endangered species, and regionally important commercial habitats, such as commercially worked oyster reefs, should also be given high priority on any habitat sampling priority list.

Table 3. General Habitat Priority Sampling Scheme

1.	Marshes	a) high productivity b) nursery ground c) low energy system
2.	Mangrove swamps	a) high productivity b) nursery ground c) low energy system
3.	Mud flats	a) high productivity b) low energy system
4.	Sandy beaches	a) delicate ecological balance b) high energy system
5.	Rocky shores	a) delicate ecological balance b) high energy system

Replicate Sampling

As a general rule, it is better to get statistically valid results from a small prudently selected number of sampling stations than to cover the entire spill area but obtain results that are not statistically valid. It is obvious that to obtain data that can be treated statistically, replicate samples must be collected at each analytical sampling station. It is impossible, however, to accurately determine the number of samples per station required to obtain data within certain error limits unless knowledge of the population mean and variance is available. Fortunately, the mean and variance measurements of a collection of samples can be used to estimate the population mean and variance. The estimated values of these parameters can then be used to predict the number of samples required to stay within the desired error limits.

Two-stage sampling procedures in which the mean and variance of the first-stage samples are used to determine the number of replications required for a certain degree of precision in the second sampling stage are often used in biological investigations (Cox 1952). Similarly, the mean and variance of analytical samples taken in Phase I of this documentation procedure should be used to determine the number of replications required to obtain the desired precision in Phase II. Somewhat arbitrarily, the minimum number of samples required at each sampling station in Phase I has been set at four. This number of samples per station is more a concession to ever-present analytical resource limitations than anything else. More samples should be taken if possible.

The number of samples required to detect a specified difference in the concentration of the spilled substance at two different sampling stations, or at the same station at different times, can be estimated using tables developed by Kastenbaum, Hoel, and Bowman (1970). These tables were developed to aid in the selection of sample size for one-way analysis of variance (ANOVAR) of up to six groups. Since one-way ANOVAR of two groups is mathematically equivalent to a t-test (Sokal and Rohlf 1973), the two group one-way ANOVAR tables can also be used to select sample size for a comparison of two groups by the unpaired t-test.

The two-group one-way ANOVAR tables presented in Figure 2 contain the maximum values of the standardized range, τ , when the means of k=2 groups, containing N observations, are compared at various levels of risk. In most experiments the level of significance (α) is usually assigned a value of 5 percent and β is normally not even computed. Vanderhorst, Anderson, Wilkinson, and Woodruff (1978) recently suggested that error risks of at least 10 percent for both α and β be adopted in biological assessment studies. Since analytical data from environmental samples also often contain considerable variation, we too recommend 10 percent as the minimum error risks for both α and β in analytical documentation studies. A 10 percent value for β sets the power (1-β) of the statistical test at 90 percent. This means that there is a 90 percent probability that a value which differs from the mean by an amount exceeding limits specified by the analyst will be detected. In this situation the analyst specified limits determine the sensitivity of the test and must be expressed as the standardized range using the following formula:

$$\tau = \frac{(\mu max - \mu min)}{S}$$

where τ is the standardized range, $\mu max - \mu min$ is the specified range about the sample mean, and S is the sample standard deviation.

Once values for α and β are selected and the standarized range is calculated, the tables in Figure 2 can be used to estimate the number of samples required to achieve the desired sensitivity. As an example, suppose that the mean concentration of petroleum hydrocarbons detected in a series of sediment samples taken at a particular sampling station in Phase I was 150 parts per million (ppm) and the standard deviation of the measurements was 53 ppm. Also, suppose that the analyst wanted to be able to detect a

Table 1. *Values of the maximum standardized range,* τ, $k = 2$

	$\alpha = 0·01$						$\alpha = 0·05$					
$N \backslash \beta$	0·005	0·01	0·05	0·1	0·2	0·3	0·005	0·01	0·05	0·1	0·2	0·3
2	23·054	21·490	17·322	15·179	12·678	10·954	10·375	9·665	7·772	6·798	5·653	4·863
3	7·782	7·322	8·141	5·527	4·800	4·288	5·160	4·853	4·024	3·589	3·071	2·703
4	5·260	4·982	4·233	3·840	3·371	3·037	3·919	3·695	3·088	2·767	2·381	2·104
5	4·220	4·005	3·422	3·114	2·744	2·480	3·308	3·122	2·618	2·348	2·024	1·792
6	3·628	3·448	2·953	2·691	2·376	2·150	2·924	2·761	2·317	2·081	1·798	1·590
7	3·235	3·074	2·638	2·406	2·127	1·926	2·652	2·505	2·104	1·890	1·832	1·446
8	2·949	2·803	2·407	2·197	1·943	1·761	2·446	2·311	1·941	1·746	1·507	1·335
10	2·552	2·427	2·088	1·905	1·688	1·528	2·149	2·030	1·706	1·534	1·325	1·175
12	2·283	2·172	1·868	1·708	1·511	1·370	1·940	1·833	1·541	1·385	1·197	1·061
14	2·085	1·984	1·707	1·559	1·381	1·252	1·783	1·684	1·416	1·273	1·100	0·975
16	1·932	1·838	1·582	1·445	1·280	1·161	1·658	1·567	1·318	1·185	1·024	0·908
18	1·808	1·720	1·480	1·353	1·198	1·087	1·557	1·471	1·237	1·112	0 961	0·852
20	1·708	1·623	1·397	1·276	1·130	1·025	1·472	1·391	1·170	1·052	0·909	0·806
22	1·619	1·540	1·328	1·211	1·073	0·973	1·400	1·323	1·113	1·000	0·885	0·787
24	1·544	1·469	1·265	1·158	1·024	0·929	1·338	1·284	1·063	0·958	0·828	0·733
26	1·479	1·407	1·211	1·107	0·981	0·889	1·283	1·212	1·020	0·917	0·792	0·703
28	1·421	1·352	1·164	1·064	0·942	0·855	1·235	1·167	0·981	0·882	0·762	0·676
30	1·370	1·304	1·122	1·026	0·909	0·824	1·191	1·126	0·947	0·851	0·738	0·652
40	1·177	1·120	0·984	0·881	0·781	0·708	1·027	0·971	0·816	0·734	0·634	0·562
60	0·954	0·908	0·782	0·714	0·633	0·574	0·835	0·789	0·664	0·597	0·516	0·457
80	0·823	0·783	0·674	0·616	0·546	0·495	0·722	0·682	0·573	0·516	0·446	0·395
100	0·735	0·699	0·602	0·550	0·487	0·442	0·646	0·609	0·512	0·461	0·398	0·353
200	0·517	0·492	0·424	0·387	0·343	0·311	0·465	0·430	0·361	0·325	0·281	0·249
500	0·326	0·311	0·267	0·244	0·216	0·196	0·287	0·271	0·228	0·205	0·177	0·157
1000	0·231	0·219	0·189	0·173	0·153	0·139	0·203	0·192	0·161	0·146	0·125	0·111

	$\alpha = 0·10$						$\alpha = 0·20$					
$N \backslash \beta$	0·005	0·01	0·05	0·1	0·2	0·3	0·005	0·01	0·05	0·1	0·2	0·3
2	7·393	6·882	6·516	4·809	3·979	3·401	5·310	4·934	3·925	3·399	2·775	2·334
3	4·313	4·045	3·321	2·939	2·482	2·155	3·585	3·348	2·703	2·381	1·049	1·653
4	3·422	3·215	2·653	2·355	1·995	1·737	2·955	2·762	2·236	1·958	1·618	1·373
5	2·944	2·768	2·288	2·033	1·725	1·503	2·685	2·418	1·958	1·714	1·418	1·204
6	2·629	2·473	2·046	1·818	1·544	1·346	2·330	2·179	1·768	1·546	1·280	1·087
7	2·401	2·258	1·869	1·662	1·411	1·230	2·140	2·001	1·622	1·420	1·176	0·999
8	2·224	2·092	1·732	1·540	1·308	1·141	1·990	1·861	1·509	1·321	1·094	0·929
10	1·965	1·848	1·531	1·361	1·156	1·008	1·767	1·653	1·340	1·174	0·972	0·825
12	1·780	1·675	1·387	1·233	1·048	0·914	1·606	1·502	1·218	1·067	0·883	0·750
14	1·639	1·542	1·277	1·138	0·965	0·842	1·482	1·386	1·124	0·984	0·815	0·693
16	1·528	1·437	1·190	1·059	0·900	0·785	1·383	1·294	1·049	0·919	0·761	0·646
18	1·436	1·351	1·119	0·996	0·846	0·738	1·302	1·218	0·988	0·865	0·718	0·608
20	1·359	1·279	1·059	0·942	0·801	0·698	1·233	1·154	0·936	0·819	0·678	0·576
22	1·294	1·217	1·008	0·897	0·762	0·665	1·175	1·099	0·891	0·780	0·646	0·549
24	1·237	1·164	0·964	0·858	0·729	0·636	1·124	1·051	0·852	0·747	0·618	0·525
26	1·187	1·117	0·925	0·823	0·699	0·610	1·079	1·009	0·818	0·717	0·593	0·504
28	1·143	1·075	0·890	0·792	0·673	0·587	1·039	0·972	0·788	0·690	0·571	0·486
30	1·103	1·038	0·860	0·765	0·650	0·567	1·003	0·938	0·761	0·666	0·552	0·469
40	0·952	0·896	0·742	0·660	0·561	0·489	0·867	0·811	0·658	0·576	0·477	0·405
60	0·775	0·729	0·604	0·537	0·457	0·398	0·707	0·661	0·536	0·470	0·389	0·330
80	0·670	0·631	0·522	0·465	0·395	0·344	0·611	0·572	0·464	0·406	0·336	0·286
100	0·599	0·564	0·467	0·415	0·353	0·308	0·547	0·511	0·415	0·363	0·301	0·256
200	0·423	0·398	0·330	0·293	0·249	0·217	0·386	0·361	0·293	0·257	0·212	0·180
500	0·267	0·251	0·208	0·185	0·157	0·137	0·244	0·228	0·185	0·162	0·134	0·114
1000	0·189	0·178	0·147	0·131	0·111	0·097	0·173	0·161	0·131	0·115	0·095	0·081

Figure 2. Two group, one-way analysis of variance tables developed by Kastenbaum, Hoel, and Bowman (1970), which can be used for selection of sample size for a comparison of two groups by the unpaired t-test. Reproduced by permission of the Editors of *Biometrika*.

20 percent change in the petroleum hydrocarbon concentration at that same station in Phase II. The standardized range $\tau = (\mu max - \mu min)/S = (180-120)/53 = 1.132$, and the number of samples required with the α and β values set at 10 percent is, from the $\alpha = 0.10$ table, 14. (Quadratic interpolation must be used with these tables.) If this number of samples is prohibitively large, then the sensitivity requirements must be reduced and/or the error risks must be increased. If the analyst accepts this number of samples, he is estimating that there is a 90 percent probability that a 20 percent change in the Phase I concentration of petroleum hydrocarbons at that sampling station will be detected if 14 samples from that same station are analyzed in Phase II.

The number of samples generated from the extensive Phase I sampling program proposed in the preceding sections could be very large. One means of reducing the number of samples actually analyzed is to subject the samples to preliminary analysis for the presence of the spilled substance. The results of such preliminary screening could then be used to eliminate unpromising sample sets. Samples that are not selected for analysis should be stored for possible future analysis, not discarded.

Another method of reducing the number of samples analyzed is sample pooling. For instance, once an estimate of variation within a particular sample type is obtained in Phase I, the remaining samples of that sample type taken at similar sampling stations could be pooled prior to analysis. Pooling of samples should, however, be done with discretion, especially if the data generated from the pooled samples could possibly be used in court. The reason for this is that when samples are pooled the effects of the variation within the set of samples on the data are reduced at the expense of losing the capability of measuring the variance within that set of samples. This severely limits the range of possible statistical treatments of the data thereby reducing both its scientific and legal values. Another problem with sample pooling is that it usually requires that subsamples be taken from a homogeneous mixture of the pooled samples. The fact that certain sample types, such as sediments (Chesler et al. 1976), do not readily form homogeneous mixtures when pooled could introduce a significant additional source of error into the analysis.

The same procedures described previously for estimating the number of samples required to achieve a specified level of analytical precision can be used to estimate the optimum number of samples for each sample pool.

Since sampling in Phase II should be more selective than in Phase I, fewer samples should be collected at this stage. Pooling of samples in Phase II, then, should not be considered unless there are severe resource limitations.

Sampling Patterns

The sampling pattern for each individual spill should be determined only after the spill site has been viewed firsthand. As a selection guide, general sampling patterns for spills of water miscible and nonmiscible substances at two different types of marine locations are presented below.

Offshore spills. For analytical documentation of a spill it is desirable to establish both horizontal and vertical concentration gradients, if they do in fact exist. The horizontal gradient should be established from the source of the spill to control or background concentration levels at a distance away from the source. When a water miscible discharge is leaked into offshore waters under steady environmental conditions, horizontal gradients can most easily be defined by sampling a transect directly through the gradient. If the direction of the gradient from the source is not obvious a series of transects emanating from the source of the leak in all directions will usually detect it. This type of sampling pattern is illustrated in Figure 3. Vertical gradients can be detected by sampling at various levels in the water column along a transect that defines the horizontal gradient. In shallow coastal areas, such as bays and estuaries, vertical gradients may not be formed. This is especially true if the spill is large or occurs during a period of intense wave action. In stratified estuaries, concentration breakpoints may be established when sampling vertically.

In a situation where the spilled substance is not miscible with water it is usually necessary to deal with a water-soluble fraction of the substance, dispersed droplets of the substance, and a slick on the surface of the water. Petroleum will be used hereafter as an illustrative example of this kind of spill.

Under steady environmental conditions, a slick formed from a point source of leaking oil will form a plume-like slick that eventually breaks up into patches. This process is best documented by aerial color or infrared photography (Worsley 1970). Samples taken from the intact slick at progressively greater distances from the source can be used to document the weathering process. Oil taken further from the source would naturally be weathered to a greater extent than oil taken nearer the source. Although the concentrations of dissolved and dispersed oil are generally higher beneath an oil slick, attempts to establish a gradient of petroleum in the water column by sampling from the source outward under the slick are not generally fruitful. This is because the movement of the slick is determined to a large extent by wind direction (Lissauer et al. 1977); movement of the dissolved and dispersed oil in the water column is determined primarily by subsurface water currents. This can result in situations where oil slicks are located at one position in relation to the spill source and the highest concentrations of dissolved and dispersed oil in the water column are located elsewhere (Kuhnhold 1978).

Analytical delineation of the solublized and dispersed oil in the water column is obviously an extremely difficult problem to solve with any degree of accuracy. The situation is further complicated by observations that oil slicks act as mobile secondary sources of petroleum hydrocarbon contamination. Under extreme conditions, spilled oil can also be driven into the sediment

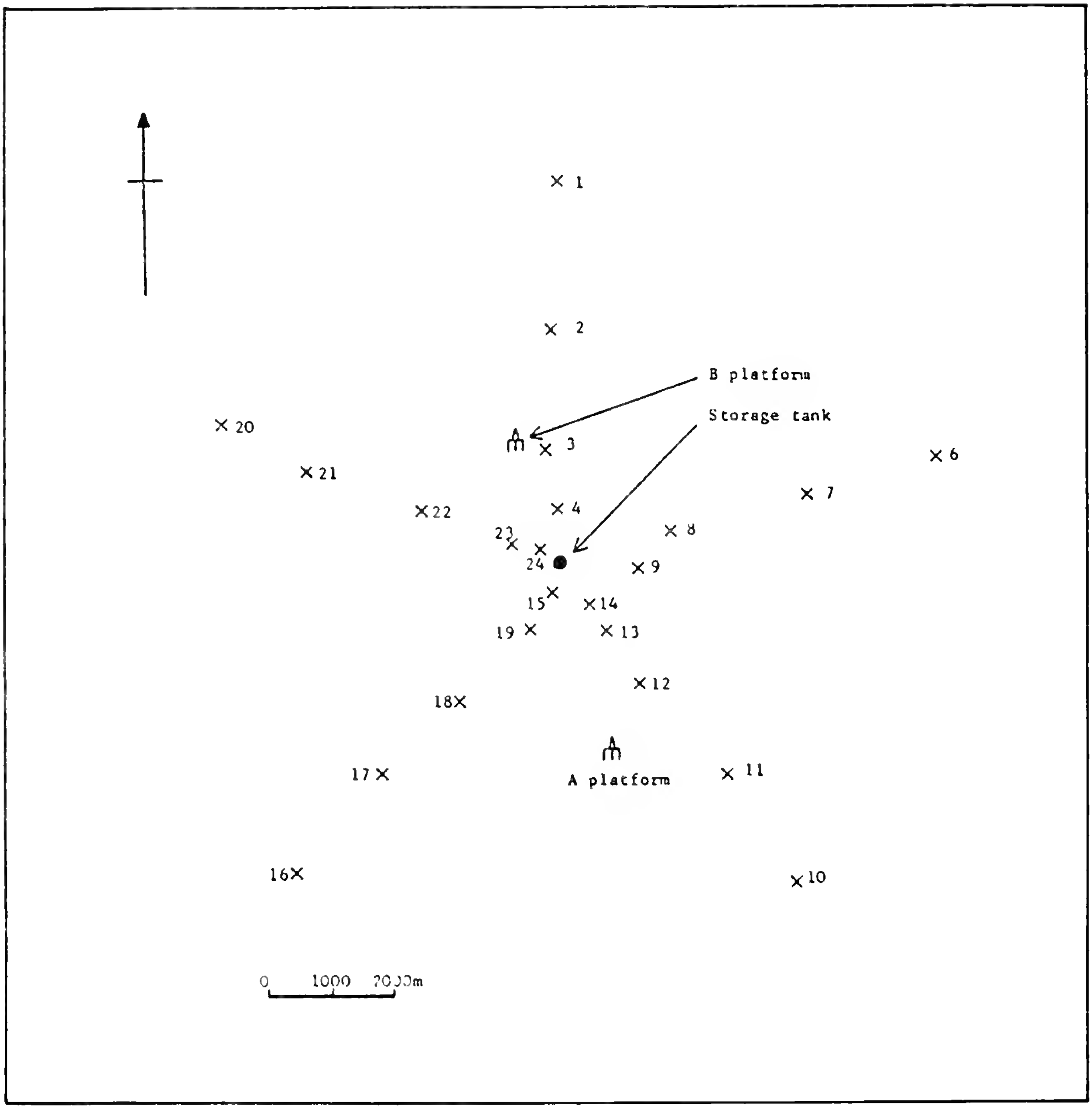

Figure 3. An example of a sampling pattern made up of a series of transects all emanating from a storage tank. These sampling stations were originally used in a biological monitoring program to assess possible effects of ballast water discharged from the central storage tank in the Ekofisk oil field. Analytical samples were taken from these and other sampling stations after the Ekofisk blowout which occurred on the B platform. This figure was adapted from "Biological Monitoring of Sediments in Ekofisk Oilfield" (Addy et al. 1978).

and function as a stationary secondary source of petroleum contamination (Galt 1978). The logical approach to analytical sampling in these situations is to use a sampling grid. Since the areas covered by even small oil spills can be extremely large, the use of a sampling grid for simple random sampling could be both time consuming and costly. Sampling grids, such as the one depicted in Figure 4, are therefore most often used for selective sampling or systematic random sampling of spill areas.

A recently introduced towed underwater fluorometer (Calder 1978) used for monitoring solublized and dispersed oil in the water column will undoubtedly be useful in delineating future oil spills in the marine environment. Unfortunately, accurate calibration of this instrument is not possible and hydrocarbon concentrations in the water column are reported in equivalent units of crude oil.

<u>Shoreline spills</u>. Spills that occur from a point source on or very near shore should also be sampled so that concentration gradients can, if possible, be defined. This can be accomplished by sampling a series of transects all emanating from the source of the spill and moving outward in a fan-shaped pattern, such as that illustrated in Figure 5A. Another approach to this same problem is to sample a series of transects perpendicular to the shoreline. One transect should run through the source of the spill and the others should be arranged parallel to the center transect. As indicated in Figure 5B, a shoreline impacted over a broad area can also be sampled by a series of parallel transects running perpendicular to the shoreline. Samples should be taken along each transect until background concentrations of the spilled substance are reached. One way to determine when to stop sampling when in the field is to smell the sample and stop when the aroma of the spilled substance can no longer be detected. A sensitive nose can detect gasoline at concentrations of 5 parts per billion (ppb) in water (Melpolder et al. 1953). If this use of the olfactory senses is contemplated, care should be taken to make sure that the spilled substance is not noxious.

As indicated previously, the minimum number of samples per sampling station should be four. The distance between sampling stations should be determined by the characteristics of each individual site. For example, transects off narrow, steep shores should have sampling stations about every 20 feet with the four samples (of sediment) randomly collected at each station from an area of approximately 10 feet by 10 feet. For long sloping shores, transects should have sampling stations about every 60 feet, preferably with eight samples randomly collected in an area of approximately 30 feet by 30 feet.

SAMPLE COLLECTION METHODS

A number of specific methods for collecting various types of samples are presented in Table 4. Even though the methods described in this table were used for sampling oil spills, they are also applicable to sampling other

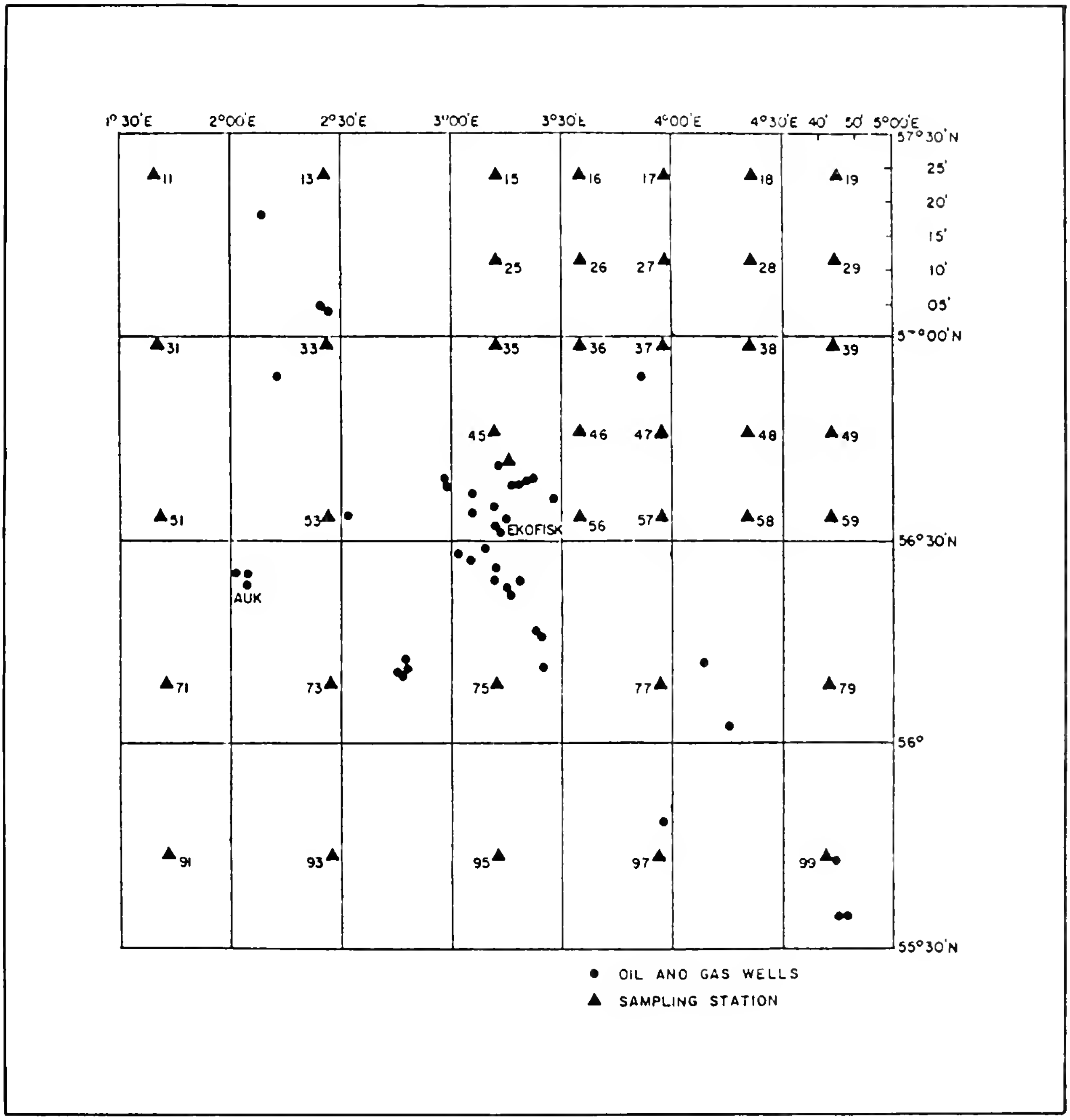

Figure 4. Sediment samples were collected at each of the indicated locations on this 100 mile square sampling grid following the Ekofisk blowout, which occurred at the B platform in the Ekofisk field. This figure was adapted from "Presence and Sources of Oil in Sediments and the Benthic Community Surrounding the Ekofisk Field After the Blowout at Bravo" (Johnson 1978).

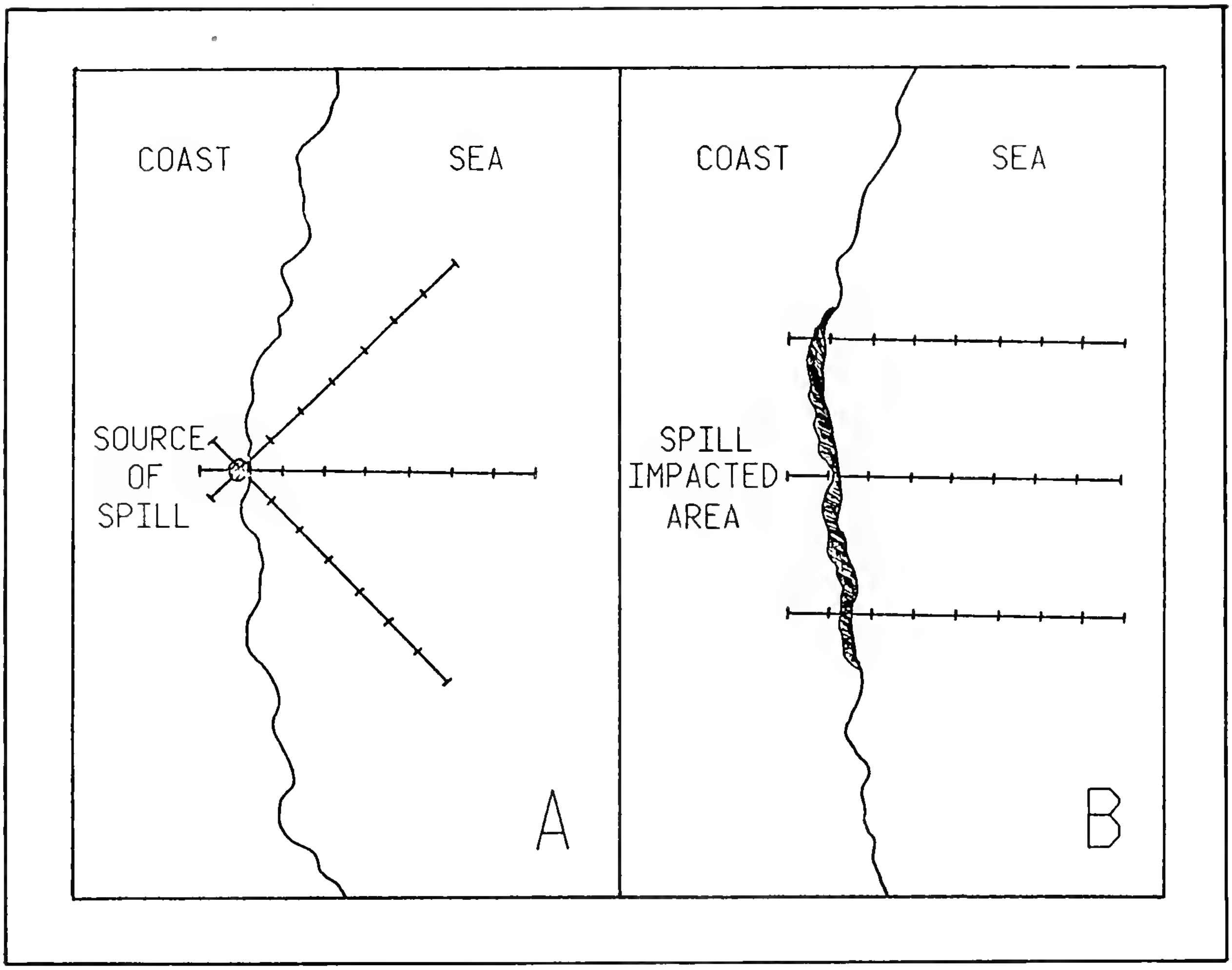

Figure 5. Sampling patterns utilizing transects laid out in a fan-shaped pattern (A) and in a parallel pattern (B). Transects laid out in a parallel pattern also can function as sampling grids.

types of spills. They are presented here as examples of general sampling techniques. No sampling methods, however, are truly universal, such that they could be used to collect uncontaminated samples at any kind of chemical spill. The laboratory that will do the analyses of samples from a particular spill should be consulted about sampling methods prior to the actual collection of samples at the spill site. Such consultation would eliminate sample collection, preservation, and/or storage errors that could make analysis of the samples useless.

Generally, the only materials that should be allowed to come into contact with a sample during collection or storage are glass, Teflon, aluminum foil, and stainless steel. One notable exception is that samples designated for atomic absorption analysis should be collected and stored in acid (HNO_3) rinsed polyethylene bags or jars. Glass jars used for collecting or storing samples should be covered with Teflon or aluminum-lined lids. All glassware should be meticulously cleaned by one of several available acid-washing techniques (Goda 1970, Chesler et al. 1976), or an equivalent procedure involving high temperature (about 500°C) bakeouts in an annealing oven. A representative sample of each lot of cleaned glassware should be tested for contamination by gas chromatographic analysis of pentane washes. The pentane washes should be analyzed using both a flame ionization detector and an electron capture detector. These results should be recorded as documentation of the cleanliness of the glassware used in sample collection and storage. Detection of squalene in the pentane washes usually indicates the presence of fingerprints on the inside of the glassware. Sample collection gear should be cleaned prior to use by detergent washing followed by rinsing with appropriate organic solvents. Sampling gear should also be thoroughly rinsed with water or some other appropriate solvent and air dried between collections of replicate samples in the field.

Sample presentation by freezing has general applicability because it does not involve the use of chemical preservatives. The expansion of water at temperatures below 4°C must, however, be considered when samples containing large amounts of water are frozen in glass containers. For instance, glass jars containing water or wet sediment samples should be filled to no more than half their capacity if they are to be stored below 0°C. Freezing glass sample jars on their sides further reduces the possibility of breakage due to ice expansion (Chesler et al. 1976).

As indicated previously, collection methods for a variety of sample types are outlined in Table 4. Included in this table are methods of sample preservation, estimated sample sizes required for analysis, equipment required for sample collection, and pertinent comments related to the collection of each sample type. Although not indicated under the Method of Preservation heading, all samples should be stored in the dark to prevent photodecomposition prior to analysis.

ANALYTICAL SAFEGUARDS

Spill investigation technology has not yet reached the point of standardization. It is unlikely that there will ever be a single analytical technique applicable to all spill situations. It is, however, possible to standardize analytical techniques for certain classes of compounds, such as petroleum hydrocarbons, that are often spilled or dumped into the environment. Standardization of analytical methods is desirable from a legal standpoint because data obtained using standard methods carry with them the implication, often undeserved, of a high level of reliability. Scientifically, and also legally if the point is pursued, all analytical results, whether obtained by standard methods or not, should be accompanied by quality assurance data that specifically indicate their reliability. Data reliability expressed in terms of

Table 4. Collection Methods for Different Sample Types

Sample type	Required for analysis*	Equipment required	Method of preservation	Comments
Sediment	100 to 200 g w.w.[+]	Hand corer (Chesler et al. 1976, McAuliffe et al. 1977) 2 in. diameter, stainless steel (10 to 120 cm cores)	Freeze the entire core or sections - below 0°C	Undisturbed subtidal sediment samples should be collected by divers down to a depth of 30 m (Fager et al. 1966).
Sediment	100 to 200 g w.w.[+]	Vessel mounted box corer	Freeze the entire core or sections - below 0°C	A corer should be used even in deep water because undisturbed samples taken in this manner can be analyzed in discreet sections rather than as subsamples of composite grab or dredge samples. If a vessel mounted corer is not available grabs or dredges should be used. (See Benthos sample type.)
Water column	1 to 3 l	Weighted drop sampler (Chesler et al. 1976)	Freeze below 0°C (IMCO et al. 1977); Add $CHCl_2$; Add $HgCl_2$	The drop sampler must be sealed when it enters the water and also when it is withdrawn from the water.
Water surface	1 sample	Teflon disc (Miget et al.) 1974) (27.9 in. diameter)	Freeze below 0°C	The Teflon disc is touched lightly to the water surface and then rinsed with dichloromethane.

Table 4. (continued)

Sample type	Required for analysis*	Equipment required	Method of preservation	Comments
Water surface	1 sample	Stainless steel (Mackie et al. 1977), Wire screen, (200 mesh - 67 by 100 cm)	Freeze below $0^{\circ}C$	The wire screen is touched to the water surface and then rolled up and placed in glass extraction tube.
Atmosphere	60 l (air)	Gas samples (Pellizzari et al. 1976), Universal Sampler 5-1068++ and Tenax Adsorbent Cartridges	Freeze Tenax cartridges below $0^{\circ}C$ in 25 by 200 mm Pyrex glass tubes covered with Teflon-lined caps	Transport and storage blanks (Tenax cartridges) should be run with each set of samples.
Benthos	100 to 500 g w.w.+	Hand corer (Chesler et al. 1976, Michael et al. 1977) 2 in. diameter stainless steel (10 to 120 cm cores)	Freeze the entire core or sections - below $0^{\circ}C$	Undistrubed benthos (and sediment) samples should be collected by divers down to 30M (Fager et al. 1966).
Benthos	100 to 500 g w.w.+	van Veen grab (Lie and Pamatmat 1965)	Freeze below $0^{\circ}C$	This grab does not penetrate well and can be used for epifaunal samples.
Benthos	100 to 500 g w.w.+	Day grab (Addy et al. 1978) or Smith-McIntyre grab (Smith and McIntyre 1954)	Freeze below $0^{\circ}C$	These grabs penetrate to a depth of about 10 to 20 cm to give a better depth profile than the van Veen grab.

Table 4. (continued)

Sample type	Required for analysis	Equipment required	Method of preservation	Comments
Benthos	100 to 500 g w.w.$^{+}$	Vessel mounted (Michael et al. 1977) box corer	Freeze the entire core or sections - below 0°C	Most infauna are just a few centimeters below the surface of the sediment, so a corer is not generally required for collection of infaunal samples.
Plankton	100 to 500 g w.w.$^{+}$	Bongo Nets (Birchard et al. 1978), 233 um & 505 um (zooplankton, fish eggs, and larvae)	Freeze below 0°C	Plankton samples are taken by surface neuston tows and oblique hauls. Such samples taken at oil spills are often contaminated by oil droplets and tar balls that are collected in the nets. In such cases, visible fluorescence of oil contaminated zooplankton, observed by U V microscopy, can sometimes be correlated with the spill incident.
Plankton	100 to 500 g w.w.$^{+}$	Niskin bottles (Birchard et al. 1978) (phytoplankton)	Freeze below 0°C	

Table 4. (continued)

Sample type	Required for analysis*	Equipment required	Method of preservation	Comments
Pelagic organisms	100 to 500 g w.w.+	Trawl (Hay 1977)	Freeze below 0°C	Each organism selected for analysis should be individually wrapped and/or placed in a glass container. Sample pooling should be done in the analytical laboratory.
Birds	100 to 500 g w.w.+	Landing net (for dead or debilitated birds)	Freeze below 0°C	Individual birds or tissues taken during necropsy should be wrapped in aluminum foil and/or placed in a glass container. Sample pooling should be done in the analytical laboratory.

* Estimated amount
\+ Wet weight
++ Manufacturers name used only as an example

the accuracy and precision of the measurements should be documented by a series of interlaboratory and intralaboratory quality control measures. Interlaboratory calibration exercises utilizing such aids as split or duplicate samples provide consensus verification of analytical accuracy and should be systematically incorporated into every analytical documentation program. Consensus verification of analytical accuracy is particularly important in the case of environmental samples because certified standards are not usually available to confirm the absolute accuracy of the data.

Intralaboratory quality control measures serve primarily as a check on the precision of the analytical data. Intralaboratory control measures should include such procedures as routine instrument calibrations, analysis of system blanks along with each set of samples, replicate analyses, and preanalysis tests of analytical accuracy, reproducibility, and linearity over the expected concentration range. Of course, the results of all interlaboratory and intralaboratory quality control measures should be documented for presentation along with the analytical results obtained from the environmental samples.

Amore (1978) recently proposed the comprehensive quality assessment protocol, incorporating both external (interlaboratory) and internal (intralaboratory) quality control components, be followed as closely as possible by laboratories doing spill documentation analyses.

Table 5. Analytical Quality Assessment Protocol

I. Internal components

   A. Blind duplicate
   B. Spiked blanks
   C. Spiked samples
   D. Certified standards
   E. Instrument control chart
   F. Synthetic samples
   G. Secondary standard samples

II. External components

   A. Proficiency samples
   B. Round robins
   C. Blind duplicates

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DOCUMENTATION AND DAMAGE ASSESSMENT: THE KEYS TO DEVELOPING A MORE EFFECTIVE SPILL RESPONSE STRATEGY

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A new era is approaching in oil and hazardous spill control as a result of proposed Superfund legislation in the United States, revised international conventions and insurance programs, and the ultimate fate of the billion dollar level litigation over the *Amoco Cadiz* spill.

In this presentation I will discuss:

1. why I think this new era is approaching and particularly how documentation and damage assessment are involved,

2. why I think it is needed,

3. how I think it will affect industry and government spill response,

4. what role my institution believes it will play in this new era, and

5. a planning activity entitled Engineering and Scientific Studies Before, During, and After a Spill under development for our program that may have useful components for planning activities.

NEW ERA

The last decade was significant because it saw the establishment of programs to clean up oil spills both in the United States and abroad. Costs for cleanup activities were paid by the spiller from insurance programs, or government treasuries. These were major breakthroughs in their time!

New programs being introduced call for the third party damages and in some cases environmental/ecological damage to be paid from similar sources.

Proposed Superfund legislation provides for both and such international programs as the Civil Liability Convention, Tanker Owner's Voluntary Agreement concerning Liability for Oil Pollution (TOVALOP), Contract Regarding an Interim Supplement to Tanker Liability for Oil Pollution (CRISTAL), and the Fund Convention provide for the third party damages.

Two factors emerge:

1. Cleanup response and economic and environmental damage are highly interrelated. Effective cleanup indicates low damage; poor cleanup indicates high damage.

2. Someone will have to determine and defend the assessment for each of the three costs.

As a result, documentation not only of cost but also of response method and qualitative and quantitative damage caused by the spilled material and by its cleanup will be essential.

I happen to think this is good. Over the last few years I have been in a position to view on occasion United States and foreign response programs. I see the following limitations in the United States program:

1. There are nine generally good Federal Regional Oil and Hazardous Substances Pollution Contingency Plans, but only a few well-designed, site-specific contingency plans.

2. Some good responses have occurred but also some very, very poor ones have happened.

3. A useful selection of specialized tools has been put together but a limited inventory is available.

4. There has been a definite lack of public documentation of spill responses and impact.

5. An emerging group of qualified people has been developed, but it is eroded continually by the transfer of industry and government personnel since spill control is not a viable career path.

6. Many watchers and turf defenders are at the spill site but not enough technical "doers" are there.

THE EFFECT

This new era will require a more efficient planned response. If under the proposed Superfund legislation a spiller is to be charged cleanup costs, third party damage costs, and environmental costs, he is going to demand proof that the charges are correct and not inflated because of improper response, poorly timed execution of response efforts, unnecessary response induced damage, or incorrect assessment of impact.

The methodology for carrying out the damage assessments must be thoroughly documented and defended.

One should also expect that the spiller will have a first-class team in the field to verify what is happening and to protect and defend his position. If a bill were sent to a spiller for $5 million in cleanup costs, $5 million in third party costs, and $20 million in environmental damage relating to a spill, would one expect otherwise? He would be foolish not to initiate such a technical response.

TAMU PROGRAMS

At Texas A&M, a need to develop a program to support spill control activities has been identified. It is worthwhile to create and maintain an academic knowledge base in this area and to use it in our roles of teaching, public service, and research. The core program is called the Oil Spill Technical Assistance Program. It is housed at the engineering research arm of the Texas Engineering Experiment Station. The station's legislative charge as a State agency is to aid both government and industry. This will be a dual role in the future. Related components involve graduate academic training in the Environmental/Civil Engineering Department and applied training at the Texas Engineering Extension Service Oil Spill Training School. To support this program, a prototype field response capability is being built for use both for actual technical responses and a graduate training laboratory. Participation on a contract basis at spills is continually upgrading both the logistics base and analytical capability. The objectives of the overall program are:

1. to determine how to carry out fast, efficient, and economical response and cleanup of oil spills under a wide variety of circumstances;

2. to develop and present training activities for U.S. and international audiences to aid the participants in planning and executing fast, efficient, and economical response and cleanup;

3. to provide technical assistance to individuals and groups who need help in preparing to deal with spills or in responding to actual spills.

In carrying out these objectives, the Environmental Engineering Division has developed a 1-week international training course which is currently being presented throughout the world on a contract basis for the Intergovernmental Maritime Consultative Organization (IMCO) and United Nations Environment Program (UNEP) programs of the United Nations and for individual countries. An expanded version of this course is being taught as a graduate

Civil Engineering course at Texas A&M University although most of the students are nonengineers.

Several years ago the Environmental Engineering program developed for the American Petroleum Institute (API) a practical, "hands-on" 1-week training course for first level field managers. This course is now presented approximately every 2 weeks through the Texas Engineering Extension Service at Galveston, Texas. It is particularly recommended to those wanting an initial knowledge of the basic fundamentals and equipment in the field.

The technical assistance program is particularly focusing on the design of response activities. The Program is primarily aimed at providing practical input to the cleanup operation and documentation of where the oil goes, how it changes from day to day, and the physical impact of the oil and its removal. Highly analytical biological or chemical studies are not being attempted.

In carrying out the design of this program, the planning phase is continuous. I plan to further discuss this program in its current status. The overall plan consists of several steps:

1. the identification of general goals, roles, or activities;

2. the development of specific task items;

3. the identification of the logistical and analytical core needed to carry out the task;

4. a detailed procedures manual for each task including field forms, analytical methods, and methods of displaying results.

ENGINEERING AND SCIENTIFIC STUDIES BEFORE, DURING, AND AFTER A SPILL

Through the many oil spills which have occurred in the past, it has been discovered that not only was the country poorly prepared to deal with the cleanup components of a spill, but the country was also not prepared to deal with the scientific and engineering components.

The tremendous economic, social, and environmental costs of a major oil spill make it extremely important that the scientific and engineering communities play a significant role in the contingency planning activities, the spill response, and the spill followup. Perhaps these needed studies before, during, and after a spill could become the components of an Engineering and Scientific Contingency Plan.

One purpose of this paper is to discuss the specific components of such plans and to discuss the program to determine the scientific and engineering tools needed on hand to carry out such studies.

The format of the planning activity is that of identification of task components rather than that of detailed project plans. The latter would be formulated as part of the continuing contingency planning and response program.

Scientific and Engineering Activities Prior to the Spill

The success of oil spill control operations is highly dependent on preplanning operations. For the scientific and engineering community, these preliminary activities generally fall into two categories: (1) information needed for the planning and response activities, and (2) information needed for the assessment of the impact of an oil spill. These two categories of data are not mutually exclusive. Information gathered for one purpose will be useful for the other.

A group of nine prespill activities follows:

1. Determine what areas need to be protected by identification of areas susceptible to damage and the relative risk of impact.

2. Determine the physical properties of the oils transported in the area with regard to how they behave if spilled and what will be their environmental impact.

3. Develop methodology to determine where the oil will go in the event of a spill.

4. Determine how environmental systems are to be protected by providing information on products and procedures for oil spill cleanup including test programs, studies of oceanographic and hydraulic features, and properties.

5. Provide information on technology of protection and cleanup, beach access and transportation, and selection of disposal sites.

6. Evaluate logistical resources capable of supporting the cleanup effort.

7. Develop appropriate training programs for scientific, engineering, and management personnel likely to be involved in spill situations.

8. Document the existing environment from which to measure change.

9. Develop the scientific and engineering response plan.

Scientific and Engineering Activities During the Spill

The scientist and engineer can fill many roles during the spill response. This document covers the activities of support, technical advice, and documentation which are outside of the direct cleanup operations even though many engineers and scientists may have line management roles in the cleanup. These roles are: 1) scientific support, 2) assistance in oil spill technology, and 3) documentation.

A series of 20 task items has been prepared with regard to the three major areas listed previously. These task items are:

1. establish logistical base near the spill site;
2. document the source, cause, and size of the spill for scientific and research purposes;
3. determine the type and properties of spilled material and collect a sample if possible;
4. monitor the weathering and emulsification of the spilled oil;
5. measure and/or predict information on wind, rainfall, streamflow, tides, currents, and waves;
6. determine the impacted aquatic environmental systems and obtain or determine their properties;
7. determine the impacted terrestrial systems and obtain or determine their properties;
8. predict where the spilled material will go on the surface and map actual movement;
9. determine the properties of the deposited material and obtain samples for analysis and storage;
10. provide advice to the spill response manager relating to cleanup technology;
11. determine cleanup resources employed;
12. determine overall cleanup technology utilized;
13. provide and/or record containment technology;
14. determine removal technology for beaches;
15. determine removal technology for marshes;

16. determine removal technology for rocky areas;

17. determine and document oil material mass composition, method of storage, and transportation of materials;

18. record physical changes in the areas affected by the spill and the cleanup including remaining oil, removed sand and vegetation, impact or entrance, and egress from cleanup area;

19. document cleanup methods employed;

20. conduct overall documentation of the spill response.

Scientific and Engineering Activities After the Spill

The activities after a spill fall into four major categories as follows:

1. Documentation of the conditions at the end of the spill cleanup.

2. Evaluation of cleanup costs, third party damages, and environmental damage.

3. Develop and execute plans for restoration.

4. Evaluation of overall response to improve future response capability.

Figure 1 is a typical task item. It defines the title, the subcomponents of the task, and the resources needed. The Texas A&M Program currently is developing these task item sheets for each activity and developing the resource tools to carry them out. Development of the specific procedure manual lies in the future.

The field capability developed to date includes a Winnebago Technical Command Van with a variety of logistic resources, land, sea, and air transportation capability, and transportation field kits for current measurements, meteorological measurements, photo documentation, video documentation, surveying, petroleum chemistry, and sample collection.

SUMMARY

An effective technical spill response by government, industry, or academic personnel involves following a carefully prepared plan and having the manpower, training, and equipment resources to carry out the plan. In this presentation I have described a planning activity which serves both to develop the plan and create the technical methodology to be followed. I also have described the method to determine the needed logistic and equipment resources.

It is believed that the methodology shown can be easily transferred to assist those in the Fish and Wildlife Service and other Government agencies in planning their response activities.

Task Example. Predict Where the Spilled Material Will Go on the Surface and Map Actual Movement.

How to accomplish this task:

1. From information obtained concerning the solubility of the spilled material, estimate the quantity of material likely to go into the solution and the size of the subsurface slick.

2. Using dyes, tag the water around the spill area. Use a flourometer or spectrometer to track the movement of the dye and the spill. Determine the stream velocity using an integrated float technique for depth profile of velocity.

3. Collect samples for determination of concentration of material in the water column in the form of dissolved or dispersed material.

4. Utilize current data to plot probable subsurface plume movement. If current data are unavailable, use an over the side current meter to obtain these currents. In a river or estuary, use integrated stream velocities, or simple current and tide flows.

5. Plot the projected movement of the plume onto maps of the area.

6. By analyzing samples of the chemical group, determine or estimate the rate of dispersal for point where concentration of material becomes too dilute to detect.

Tools Needed: maps, sample bottles, current meters, existing subsurface current data, flourometer, spectrophotometer, dyes, vessel, and equipment for deploying dyes, plotting equipment.

Figure 1. Typical task item analysis.

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The Proceedings are a compilation of papers presented at the Fish and Wildlife Service (FWS) 1979 Pollution Response Workshop, held 8-10 May 1979, in St. Petersburg, Florida. The primary purpose of the workshop was to provide FWS personnel with continuing training in responding to spills of oil and hazardous substances that may impact fish and wildlife resources and their habitats. Papers in the volume are divided into six subject areas: introductory material and a definition of the spill response problem; elements of Federal, State, local government and industry response to pollution discharges; biological and physical impacts of oil and hazardous substances; spill response techniques, including containment technology and wildlife rehabilitation; interfacing with the public, news media, and other agencies in crisis situations; and documentation of spills and environmental damage for purposes of litigation and the development of new prevention strategies.

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