PROCEEDINGS of the MESA WORKSHOP on

PRINCE WILLIAM SOUND

March 7-9, 1978

Sea Grant Report 78-9
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ALASKA SEA GRANT PROGRAM
University of Alaska
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Brenda Melteff
Editor

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EXECUTIVE SUMMARY

The impact of the ocean on man has been told in rich and sometimes awesome accounts. Since the beginning of recorded history, the power of the ocean and its creatures has contributed to the mythology which we mirror in our nature and existance.

The inverse relationship is a rather modern phenomenon. What is man's impact on the ocean? The small ripple created by a wader has now become, in many regions, a tsunami of effect. It is this potential that must be forecast and, where necessary, dampened by studying marine ecosystems prior to extensive human impact.

A study of the Prince William Sound ecosystem offers a nearly unique opportunity for enhancing our knowledge of the potential impact of human activities and the reflected results on human life. Though man has lived along the shore of Prince William Sound for many centuries, until recently his impact is a small eddy. Due to development that eddy has now taken the proportion of the wake of a supertanker.

The impact of human activity has started. The time to assess the potential magnitude of that impact is now. To that end, the people of the Sound, both those living along it and those concerned from afar, convened a series of conferences in an attempt to focus a major research effort on the question of what, where, and how great an impact we can expect from future human endeavors.

The body of this report attempts to provide this focus in detail. Herein are presented the highlights.

The current resident population of communities on the Sound is approximately 8,000 souls. It is expected this number will not expand beyond 16,000 in the foreseeable future. Further, the potential for the development of new communities is extremely limited due to the lack of available private land. The impact of local residents, therefore, appears to be minimal. However, the impact <u>on</u> these residents by other human perturbations to the ecosystem such as increased recreation, commercial transportation, mining, and fishing is maximized by the close ties all the residents have with the Sound. The Prince William Sound ecosystem, as it is presently constituted, certainly has an integrated human element living in concert with the other elements of nature. These people enjoy the fruits of this synthesis, but would also suffer dearly and directly should the Sound be adversely impacted.

One potential source of such an impact would be transient people seeking to share the wonderous recreational potential of this area. Many conference participants felt that recreational use of Prince William Sound would most likely have the largest long-range impact on the ecosystem.

The number of small boat slips, both current and proposed, at Whittier might act as an indicator of the proportion of transient to resident recreational impact. Whittier, with a 1970 population of 130 residents has 125 boat slips, with 100 more planned in 1978 and an additional 1,000 planned in the near future. This, coupled with the ever expanding tourist trade, utilizing charter vessels and state ferries, indicates a dramatic growth in recreational use in the near future. The spore of these people will be clearly evident throughout the Sound.

The non-renewable resource workshop concentrated its attention on the potential for hard rock mining operations and their impact in Prince William Sound. The consensus of this workshop was that by 1990 mining operations would begin in specified areas of the Sound. These operations would have three potential impacts on the area. Firstly, an increase in population directly related to the mining operation of approximately 2,000 people which would constitute a 25 percent increase based on the current population. Secondly, the disposal of fine tailings from the mining operations could effect the clarity and possibly the productivity of certain areas of the Sound. The effects of such impact could be easily forecast pending water current studies. Finally, the potential for conflict in the use of seaways by both ore barges and oil tankers. This is a solvable problem given proper supervision of the waterways and navigational equipment.

In short, the potential impacts of hard rock mining would be short-term and site specific. This would allow for proper management and reduction of the impact, providing key environmental parameters are known.

Physical and chemical changes within our ecosystem are referred to as "impacts" whenever subsequent changes are caused in the biota of that ecosystem. Further, impacts are generally quantified in an anthropomorphic manner, the ultimate "impact" being its effect on human welfare. Due to study of the web of life, a more sophisticated approach to environmental impact has developed. It has been realized that nearly all perturbations to the lower life forms caused by environmental degredation will, via the web of life, ultimately have an impact on the human sphere to a greater or lesser extent. In order to predict and quantify these potential impacts, it is necessary to study the biosphere in as much detail as possible. The data obtained may then be used to approximate the scope of change in an input/output model.

In essence, defining the largest data gaps and assigning these a priority ranking was the work of the renewable resources workshop. The copious and detailed results of this workshop are presented in the body of this report.

One major point discussed in this workshop, and as yet unmentioned, is the potential for environmental alterations resulting from transportation of the Trans Alaska Pipeline oil. The tanker route of this oil transects Prince William Sound. The development and operation of this transport system represents the greatest human impact on the Sound to date and at the same time, potentially, the most catastrophic impact imaginable.

What must be done to preserve the Sound should a major oil spill occur? If we acquire the information necessary to answer that question in a rational and scientific manner, we would probably have sufficient data to dampen any other man-made impact.

It is the intent of the workshop participants that this document be a basis for beginning a broad-based scientific inquiry, conducted through MESA.

INTRODUCTION

The Marine Ecosystem Analysis Program (MESA) of the National Oceanic and Atmospheric Administration has been considering undertaking an ecosystem study of Prince William Sound. As a preliminary step in this planning process, MESA contracted with the University of Alaska's Sea Grant Program to hold a workshop to define the present and foreseeable marine problems, projected development, user requirements and user conflicts in the Sound and its communities.

Preliminary to the workshop, a planning meeting and community meetings were held.

This report summarizes the results of those preliminary meetings and presents the data, discussions and conclusions reached during the workshop.

PLANNING MEETING

On November 1, 1977, a planning meeting of 18 state, federal and industry representatives was held at the Hilton Hotel in Juneau to consider the need for an ecosystem study of Prince William Sound. Further consideration of such a study was felt necessary. It was suggested that meetings be held in the Prince William Sound communities in order to get direct input from the local residents and a workshop be convened in Anchorage.

The planning conference identified four major questions which they felt should be answered by the workshop. These questions were:

what marine problems are present or foreseen?
how much development is expected and when?
what are user requirements?
what other uses conflict with these uses?

The committee also developed a basic outline of the workshop including resources to be considered under each major topic. This preliminary outline was as follows:

A. RENEWABLE RESOURCES

1. fisheries and plants -- past, present and future
2. marine mammals and birds
3. forest products
4. water

B. NONRENEWABLE RESOURCES

1. oil and gas
2. minerals

C. RECREATION (resources and activities)

1. tourism
2. recreation
3. scenic and wilderness areas
4. boating

D. URBANIZATION

1. heritage
2. waste disposal
3. power-utilities
4. land use

E. TRANSPORTATION

1. marine
2. land

Additionally the committee felt that local community input was important to the overall study and requested that local community meetings be held and that local representatives be selected to attend the workshop.

A list of attendees for this meeting is presented in Appendix A.

COMMUNITY MEETINGS

On February 12 through 14, 1978 Chris Carty, acting MESA Project Manager; Craig Wiese, Sea Grant Marine Advisor for Prince William Sound; and Brenda Melteff, Sea Grant Project Coordinator visited Cordova, Valdez and Whittier. The ecosystem study MESA anticipates doing in Prince William Sound was introduced and discussed. The schedule for these meetings was:

Cordova, Sunday, February 12;
Library Conference Room

Valdez, Monday, February 13;
City Council Chambers

Whittier, Tuesday, February 14;
City Council Chambers.

Following is the agenda followed for these meetings:

INTRODUCTION

Craig Wiese, Marine Advisory Program
University of Alaska Sea Grant Program

BACKGROUND OF MESA PROJECTS

Chris Carty, Marine Ecosystems Analysis (MESA),
National Oceanic and Atmospheric Administration

TOPICS FOR DISCUSSION

Would you like to see an environmental study of the Sound done?

What are your concerns regarding future development here?

If a study is done, what things do you want studied first?

SELECTION OF REPRESENTATIVES TO ATTEND THE WORKSHOP

The list of attendees for these community meetings is presented in Appendix B.

Cordova

On Sunday, February 12, ten residents of Cordova met to discuss the need for a Prince William Sound ecosystem study.

The future developments of concern to the residents of Cordova and which they can foresee are: increased tanker traffic through the Sound from Valdez; underwater and land mining; exploration for and development of oil reserves; establishment of salmon aquaculture facilities; development of bottomfish processing facilities; and logging in the areas of Fidalgo, Hawkins, Hinchinbrook, Montague and the Native claims areas.

In order to be prepared to assess the impact of future development on the Sound, the following study priority was developed. An inventory of the resources of the Sound would be the first step followed by a monitoring system. Subsequent studies would include mapping of the sensitive areas, the impact of the Valdez oil terminal on the Sound and especially on the herring resource, and fishermen's liability.

Perry Lovett and Bob Blake were selected to attend the Anchorage workshop.

Valdez

The items of future development of concern to the community are: fish processing facilities, fish hatcheries, logging and additional port facility development in wetland areas.

The primary studies and their order of priority, as seen by the Valdez residents, are oil as it relates to fish processing, forests, maximum use of Sound resources, a study of the western part of the Sound as a control area, a study of the eastern part of the Sound for herring relating to energy flow, halibut and crab.

Two representatives were later selected to attend the Anchorage workshop. They were Chris Hansen and Leo Moore.

Whittier

Future development concerns of the Whittier residents include salmon hatcheries; coal transport and stockpiling; enlarged small boat harbor; railroad docking facilities in Shotgun Cove to handle coal from Healy; future port for the City of Anchorage; and recreational impact consisting of boating, fishing and hunting.

Two studies were felt to be most important. First is marine mammals and second is bottom charts.

The two representatives selected to attend the Anchorage workshop were Phil Munger and Doris V. Bender.

WORKSHOP

The workshop was held at the Anchorage Westward Hilton Hotel, March 7-9, 1978. One hundred and ten persons participated in the general sessions and the four working groups entitled Renewable Resources, Non-renewable Resources, Recreation and Urbanization.

Following are the presentations made at the workshop.

The workshop agenda is presented in Appendix C.

The list of attendees is presented in Appendix D.

WELCOME

Raymond S. Hadley
Alask Sea Grant Program
University of Alaska
Fairbanks, Alaska

Good Morning. I'm happy to be here to welcome you all to the Prince William Sound/MESA Workshop. We're holding this workshop in the hopes of determining whether a program in Prince William Sound by MESA would be useful to you and justifiable to the taxpayers.

We're here to develop a broad program and to attempt to justify that program. This is the first step in developing a research plan we hope will be carried out successfully. I'd like now to comment on the agenda and then turn the program over to Frank Hebard, who is the Director of MESA, and proceed with what I hope will be a productive two days.

I trust you've all registered. If not I hope you will as your registration card will be the means whereby you receive the proceedings of this conference.

This morning's summary presentations are, as you can see, quite brief. We hope they will supply the necessary background information so that we can go into the workshops and get going on the program immediately. We will have some give and take during the summary presentations, but I do hope you'll restrict your comments to broad scope ideas, not particulars. The particulars you can all bring up in your appropriate workshops.

You haven't been assigned to a workshop. We trust you will join one that you seem most suitable for, in your own judgment. We will allow people to move around to some extent, but because of the work to be done and the short time to do it in, we ask that you essentially stick with the workshop you start with. There is the possibility that in some cases we might ask you to move so that we can gain some balance in these workshops.

INTRODUCTION TO MESA

Dr. Frank Hebard
Director, Marine Ecosystems Analysis Program
Boulder, Colorado

Thank you, Ray, I'd like to take this opportunity to thank you all for taking your time and coming to assist us in this program planning effort. I'd like to start my presentation with a quote. "Most resource managers live in a sort of twilight. They have spent their careers in an atmosphere of probabilities and of doubts, where nothing is very clear, where there are some chances for many events, where there is much to be said for several courses, where nevertheless one course must be determinedly chosen and fixedly adhered to." This quote seems to fit some of the problems that our present day resource and environmental managers face, although this particular quote was made by Walter Bagget, a 19th Century British economist, journalist and critic.

It also provides an indication of the direction in which the MESA program is focusing its efforts. It's trying to bring together information that the resource manager needs to make the best possible decision.

The Marine Ecosystems Analysis Program was established by NOAA in 1972. The purpose of the MESA program is first to focus the capabilities existing within the NOAA organizational elements into environmental studies of selected coastal areas. For example, the National Ocean Survey has a capability of ships. The National Marine Fisheries Service has extensive biological research capability and laboratories that are located around the coastal areas of the United States. The National Weather Service has its weather predictive capabilities. The National Environmental Satellite Service has a satellite capability from which we can look down on broad expanses and get information. And, we have the Environmental Data Service which also provides us with a data acquisition, data filing and data management capability.

The second area of primary MESA focus is in developing cooperative studies among other Federal organizations, the universities, state and local government researchers and the industry segment of the United States that operates in the coastal areas.

The third MESA objective is to act as a focus for synthesizing available scientific data and information to provide information necessary to environmental managers for use in decision making. Hopefully this will minimize the impact of human activities and development on coastal waters.

The MESA program has been located in several elements of NOAA, but at the present time, and for the last four years, has been located in NOAA's Environmental Research Laboratories. It has a program office which is located in Boulder, Colorado and project offices in New York and Seattle.

The main component of the MESA program is what we call regional studies. These studies are conducted in selected coastal regions where the particular study requires a capability beyond that of any one particular organization.

The characteristics of these studies are that they address and focus on key regional issues, the existing or potential problems resulting from development, economic growth, population growth, etc. They also focus on user requirements; what do the individual users of scientific data require to make the best possible decisions.

Regional studies have a limited geographic scope. They focus on interdisciplinary studies, trying to bring together all scientific disciplines necessary to address the problem, and to synthesize the data gathered into appropriate information. They focus on state of the art, scientific capability. The only Research and Development type activities that might be supported by a MESA project are instrument or hypothesis developments which can be tested, evaluated and implemented within the time frame of the project so that they are actually usable. MESA does not develop new theories and technology just for future projects.

The projects are written up as five to eight year program efforts. The New York Bight project has now been ongoing for eight, and has two more years to go. We try to be flexible in our planning so that promising avenues of research don't have to be ended just because planning activities didn't account for new discoveries. It's a requirement that the project focus be very carefully directed to particular elements of the study and not try to answer everything there is to know about an area.

The primary project emphasis is on the sources, fates and effects of critical contaminants and the impact they have on the ecosystem. "Critical contaminants" is used in a very broad sense. It can even mean extreme excesses of nutrient materials due to sewage waste disposal.

In planning one of these programs, we try very hard to identify all of the research activities that are ongoing in the area. We try to use our funds to augment relevant programs as much as possible so that those programs are actually the field operations for the MESA project. Only when no one else has either the capability or the desire to carry out the research do we, MESA, actually go out and try to enlist new research elements into the project area. We call this a gap-filling effort.

Another program objective is to identify the critical relationships within the ecosystem, and its sensitivities. One of the products

is recommended strategies whereby ecological impact of human activities in an area can be minimized or localized or even in some cases eliminated. This is particularly the kind of information that is provided to the regulatory agencies, the development concerns, and to industries, as guides to their effluent standards and things like that.

MESA has three ongoing projects. The first project started in 1972 in the New York Bight. This particular phase of it is scheduled for termination at the end of fiscal 1982.

The key regional issue that is being addressed in the New York Bight project is the use of the waters in the New York Bight area by a large number of people and industries. There are 20 million people impacting this one little segment of the coast. MESA's objective is to provide the scientific information to aid in the identification and reconciliation, if possible, of competitive and sometimes incompatible uses of the water resources of the Bight.

The big problems in the New York Bight area have been the disposal of municipal wastes. The one issue that really forced us into a more focused effort than we desired was the large quantity of sewage sludge being dumped from barges about 12 miles off the coast, and a very poorly thought out study by someone to indicate that this sewage sludge was creeping up on the beach. All of a sudden the newspapers were full of the "creeping sludge monster."

There's also a large quantity of industrial waste and large amounts of dredge spoil, much of it quite contaminated, being disposed of within a very short distance of the shoreline. One of the significant findings of the project is that sewage sludge disposal from barges is only a very minor part of the real problem as far as sewage materials are concerned.

Another problem in the Bight is the excess nutrient material going into the system. The material coming in from the rivers and the sludge dumping has caused an excess of nutrients in the New York Bight area, and every summer, due to the circulation patterns and the stability that develops in the waters of this area, an anoxia problem begins to develop. The first indications are tremendous fish kills at different times of the year, depending on how stable the water column is. The oxygen content of the water has actually gone down to zero on several occasions.

Our other regional study, the Puget Sound project, has been underway almost five years. It got started in 1973/1974, with special funds related to energy development. These funds were passed through from the Environmental Protection Agency to NOAA and MESA to initiate a study of northern Puget Sound. Particularly desired was a study to give some idea of the potential impact of increased tanker traffic in Puget Sound as a result of the Trans Alaska Pipeline system.

At the present time, the study is primarily focused on determining critical habitats, particularly in the northern Puget Sound area. It has determined background levels of hydrocarbons in selected sites around northern Puget Sound, looked at the refinery inputs of hydrocarbons, hoping to quantify that source, and has also worked on surface current trajectories. We are now in pretty good shape to project surface trajectories of oil spills if they occur.

An effort was made to determine the effects of the municipal wastes that are being disposed of in the central basin of Puget Sound. It was a very limited effort. The primary focus was on the residence time of the waters in the central basin. As a result of that study, we've learned that the flushing of the central basin of Puget Sound is quite a bit faster than had been previously reported.

The third MESA project presently underway is our Deep Ocean Mining Environmental Studies Program. We call it DOMES. It's a study of the potential impact of deep ocean mining for manganese nodules in the deep waters south of Hawaii. The first phase of the project focused on establishing baseline information; what are the current systems, what are the transparancies, what do the bottom and water column communities look like. Projections have been made as to the potential impact of this mining activity on both the bottom communities and the water column.

The problem with the deep ocean mining activity is that it acts almost like a vacuum cleaner sweeping up the manganese nodules and bringing up other materials with it. The manganese nodules get filtered out. The muds, cold water and pieces of animals that come up are dumped back into the water column.

This is not much of a problem if you have one ship, but it is projected that by the mid-2050s, if everything goes well, approximately 250 ships will be in this area. It is a large area, so it will not be very crowded. Strategies are being developed to mine the area and minimally impact both the benthic community and the water column.

Our fourth project is in the area of hazardous materials response. Many of you have been involved in some of the planning activity going on in this particular project. It's an attempt by NOAA to take a coordination responsibility in the ocean waters for federal scientific studies and for information support to the U.S. Coast Guard on-scene coordinator, during hazardous material spills.

This project was begun in response to the serious problem that developed with the Argo Merchant oil spill in Massachusetts a little over a year ago, when the U.S. Coast Guard on-scene coordinator was inundated with requests by about 40 federal and state agencies to come out and do some research. Each had his

own peculiar ideas, as well as recommendations for the Coast Guard on-scene coordinator. There were also over 250 scientists contacting the coordinator trying to find out if they could do research. He had his hands full trying to figure out what to do with the oil and how to stop the oil, and had no time to decide what science should be done.

As a result, NOAA, EPA and the Coast Guard, along with other federal agencies involved in the National Response Team, have been putting together plans to improve scientific support to the on-scene coordinator. In Alaska we have identified Nancy Maynard as the NOAA scientific support coordinator for this purpose.

Future projects being anticipated for initiation in the near future include a study in Prince William Sound, providing we get the appropriate justification and rationale. Since the formation of MESA in 1972, Prince William Sound has been considered an excellent potential area for study, but this is the first time that there seems to be a chance of getting it funded.

The other project in planning now is for the Gulf of Mexico. That project is generally focusing on the long-term effects of pollutants in the food chain of the Gulf of Mexico area. The study will relate particularly to pollutants coming into the Gulf of Mexico from the Mississippi River which drains almost two-thirds of the United States. An early objective there will be to develop or define some early warning indicators of environmental degradation.

The Puget Sound project also will begin in 1979, assuming the budget is accepted by Congress. The Puget Sound project has never been funded as originally planned. It has been only partly implemented with EPA pass-through funds. We now have support for the Puget Sound project as planned and it will continue through approximately 1983. The funds are not adequate to do a total study, but they are sufficient to focus on one of the really serious problems, the synthetic organic materials that have entered the Sound. We will also consider the problem of toxic metals in the area.

That outlines what the MESA program is. I hope it sets the stage for what you are going to be considering over the next couple of days. We are not particularly interested at this time in hearing what research projects need to be carried out. We are interested, as you can tell from this discussion, in what the key regional issues are; what the conflicts are; which resource uses are compatible and which are not.

We hope that your workshop participation will provide us with your best efforts to help us get the project planning document underway and the project supported in the next budget cycle.

I would like to turn the program over to Chris Carty, who can tell you about what she's been doing in Prince William Sound. Thank you very much.

INTRODUCTION TO PRINCE WILLIAM SOUND PROJECT

Lt. Chris Carty
Acting Project Manager
Marine Ecosystems Analysis Program
Boulder, Colorado

I'm going to tell you what the history of our involvement with Prince William Sound has been, and more specifically, what I've been doing in the last few months to get this project on the road and underway.

As Frank said, Prince William Sound was originally considered one of the areas MESA wanted to study when it was first formed. But due to the fact that at that time the Pipeline was only proposed and it wasn't a definite happening, we had a lot of trouble getting enough support. Support for the New York Bight project was vocal enough so that our efforts had to be focused in that direction instead.

We did, however, in about 1973, together with the Bureau of Standards, fund a small project in Prince William Sound to do some baseline hydrocarbon monitoring before there was any oil in the area. But this was a very limited effort. I believe we only sampled six sites and we didn't sample them very frequently or for very many different types of materials. We sampled sediments and a little bit of mussel tissue and some of the water column, but it really wasn't enough to give a good idea of what the area was like.

After the Pipeline became a reality and the terminal was established, Prince William Sound became better known around the United States. We figured it was time for us to try again to get this project started, before there is any noticeable impact, so that if in the future the Sound does change, we'll have information on the way it was, in order to prove that a change has occurred. It isn't really enough to say we all know there's been a change. We have to have the data to back it up, otherwise it's always just attributed to natural variability.

In the beginning of November we had a meeting in Juneau with a number of state and federal agency representatives to determine whether they were still interested in having a big project in Prince William Sound, and to get some initial ideas on what the issues and concerns were. We decided then to have this workshop in Anchorage, partly because there are a lot of different agencies, industries and other organizations with local chapters here and it would be inexpensive and convenient for them to attend. Having a meeting in the Prince William Sound area itself could easily get bogged down at this time of year by weather conditions, and the facilities are limited. We decided to have this workshop

here, but we also decided that since we were very interested in local concerns, we would have a series of town meetings within the Sound. We had those meetings in mid-February. We went to Cordova, Valdez and Whittier. We had planned to go to Tatitlek, but the weather didn't cooperate the day we were supposed to fly in, so we haven't been there.

At the meetings, which I thought went very well, we had a good representation of a variety of interests, expressing the towns' local concerns; what they see happening to the Sound, what they're worried about in terms of the future of the Sound, and the things that they consider to be the most important. It turned out that there are a lot of questions as to what sort of development is actually going to be taking place in the Sound and when it will be taking place.

In order for us to do any sort of valid planning, we have been trying to get the best possible information on what agencies and corporations have in mind in terms of developing the Sound. Hopefully, we have a group of people here today who can speak for their agencies and tell us what's going on presently with plans for the Sound.

Also, at the workshops we had each town select several representatives to take part in this workshop. We thought it would be helpful to have citizens who are concerned because they live on the Sound to assist in keeping the meetings on a realistic level because MESA deals with realities; we don't make the regulations we deal within them. If something is going to happen in the Sound and we have enough warning, we will do our best to advise you of alternative methods to accomplish your objective and predict the effects of the different alternatives. It is then your decision as to which alternative you are going to choose.

There are several reasons why we want to get into this particular study. One is that our business is to understand how marine ecosystems work. The other marine ecosystems we've studied have already been severely impacted by human activity and stressed in many different ways. It is very difficult to determine from these systems how a natural system really works.

After studying the heavily impacted New York Bight, moderately impacted Puget Sound, and minimally impacted Prince William Sound, we're hoping to gain some generalities about how ecosystems work, so in the future when we want to study an ecosystem, it won't have to be a major effort; we should already know the critical parameters that need sampling and the necessary sampling frequencies. We're also hoping that these regional studies will give us a time sequence of increasing human activity, increasing human impact, so that we can understand better how man has affected marine ecosystems.

One trend I've found is that Alaskans tend to be split into two camps; preservation or development. We're hoping to propose a third alternative. It seems to us that the reason some people are against development is that development in the past has usually meant ruining the ecosystem or at least impacting it in a very negative manner. We think if you understand an ecosystem before developing it, you can develop it in a manner that will have a very minimal impact.

Even the largest corporation, if it wants to develop with minimal impact, really doesn't have the resources to do this kind of study. When they write their environmental impact statement they go in with the point of view of wanting to develop.

What we're hoping to do is to get into the area before any impact occurs, get all the information together, and put it into a form that's easy to use by the people who make decisions. We don't want to have a shelf full of volumes with data and data and data, because the people who really make the decisions don't have the time to read it all. We're trying to get an understanding of the system and then express it in a very simple form, something that someone who doesn't have a scientific background, a businessman or politician, can read, understand and find useful.

We're hoping that by understanding the system, giving this information to anyone who wants it, and working closely with anyone who has any development plans, we'll be able to predict the effects of different alternatives. Then, hopefully, they'll choose the best alternative.

We are not regulatory. We give our information to regulatory agencies or to developers or to anyone. We don't go in with a point of view; we're trying to find out. We're a federal scientific agency. The NOAA Environmental Research Labs have a fairly good reputation for doing science and not for trying to push their own point of view. They're out there to find out what's going on and to make the information available to everyone.

We have to develop what we call a project development plan, which is our plan for the project, dealing with the scope, goals and objectives, reason for the project and very broad general concerns and issues; why we're in there and what we hope to accomplish. We are looking to this workshop to provide the necessary information.

Since the Government has a rather strong history of responding mainly to crises, we have to do an especially good job for this project development plan because there is no crisis here right now. We think it would be easier and cheaper to prevent a crisis now than it will be to fix it if it happens. Since this is kind of an unusual way for the Government to go about things,

we have to make this a really good document in order to sell it. We want to get this project started now while we can get the information at an early stage, and achieve the maximum benefits.

What we're expecting to get from you today is as much information as you can give us on development that you know is coming into the Sound, and development that's possible based on your knowledge of the kinds or resources in the Sound. Knowing the types of development that are likely to occur, we can figure out how they will impact the system and what kind of information is needed so we can minimize impacts.

We want to determine something about which uses of the Sound conflict with other uses, because the multiple use concept is important today. It's important to know which uses are going to preclude other uses for the Sound.

We are a Colorado office and Alaska is very, very different from everywhere else. The only way we can really get an idea of the issues facing the Sound and the concerns of the people in Alaska for the Sound is to come here and speak with you. Just coming up and looking around myself and talking to people in the agencies really can't give me the kind of information I need to get this document together and sell this program. That's what this is all about.

SUMMARY OF THE FISHERY RESOURCES

Robert McLean
Special Projects Office
Alaska Department of Fish and Game
Anchorage, Alaska

I'd like to apologize for not having a representative from our management staff in Cordova here with you today but a conflict in schedules has prevented their attendance. After the introduction I was given, perhaps I should further qualify myself by saying that I do not actually have direct experience with the fishery resources of the Prince William Sound area. Rather, for the past two and a half years I have been involved in a project aimed at documenting and mapping existing fisheries resource information on a statewide basis. The basic thrust of this project has been to pull existing baseline data together under one cover for use as a land and renewable resource use planning tool, a function right in line with the task we have laid out for us today.

There are several ways in which I could lay out this presentation but given the time restraints and the nature of this workshop, I believe it will be best if I restrict my comments to a general overview of the existing fisheries--followed by a more in depth look at some of the currently underutilized fishery resources and the associated management and use conflict problems we can expect to occur with their development. Although time does not permit an in depth analysis, I would like to finish this address with a quick overlook at some of the major use conflicts that we are currently facing or can expect to face. As outlined in our agenda, I believe this will be a major point of consideration during our workshops.

Existing fisheries in the Prince William Sound area operate on five species of Pacific salmon, three species of king crab, tanner crab, dungeness crab, several species of shrimp, herring, herring spawn on kelp, razor clams, halibut and miscellaneous bottomfish. The salmon resource is the most economically important fishery product harvested. In 1975, for instance, it contributed nearly 75 percent of the total fishery value to the fishermen. The value to the fishermen of all fish and shellfish caught in the area in 1975 was over $10 million with a wholesale value of approximately $18 million.

A great deal more could be said of the existing fisheries in the Prince William Sound area. However, the main point I wish to leave with you this morning is that this is a multi-million dollar resource that sustains the largest portion of this area's economy. A great deal of basic life history, trophic and stock interaction data is still needed before we can fully understand and manage

these resources. Multiple use conflicts are occurring now and will continue to occur as the Sound is opened up to human and natural resource use development, however, at this point I believe I will save this discussion for this afternoon's workshop.

There are a number of fishery resources within Prince William Sound which are currently being looked at for possible exploitation. The first of these which I would like to discuss with you today is the snail fishery for *Neptunea* sp. which has also been rapidly developing in the Bering Sea area. Within the Prince William Sound area it has long been known that significant numbers of snails (*Neptunea*) are often brought up in several localities as an incidental catch of the tanner crab fishery. Until this year, this resource has not had a market and has been simply discarded overboard. This season, North Pacific Processor's Inc., which is largely a Japanese owned firm, has been buying *Neptunea* from fisherment delivering tanner crab to them. To date approximately 5,000 pounds has been landed. Given that the market is not fully developed and only one processor is currently buying, it is not expected that the harvest will exceed 20,000 pounds this season. Most of the incidental catch is still being discarded overboard. Very little is presently known about the distribution or stock abundance of this resource. Concentrations are currently known to exist in the 100 fathom trench off Montague Island and in South Hinchinbrook Entrance. Preliminary stock guestimates are not extremely high, but additional stock assessments are needed before we can estimate the size this potential fishery could assume.

The next potential resource I would like to address today is that of hardshell clams. Preliminary surveys have indicated that commercial quantities of Butter Clams (*Saxidomus giganteus*), Little Neck Clams (*Protothaca staminea*) cockles (*Clinocardium nuttallii*) and Horse Clams or gapers (*Schizothaerus nuttallii*) may exist within Prince William Sound. Although one fisherman currently has a dredge and a processor is willing to buy the product, the development of this potential fishery resource is presently stymied by several problems. Distributuion and abundance estimates for these resources are not well developed. A better understanding of these, as well as growth and allowable yield figures must be obtained before a management plan can be developed. Presently the most pressing problem is that of beach certification. Initial certification, and the development of an ongoing monitoring program, including fiscal support, must occur before this fishery can develop.

Bottomfisheries, particularly with the passage of the 200-mile extended jurisdiction, has lately become an important and popular topic of conversation. Some interest has been expressed in the Prince William Sound area as to the possibility of developing a bottomfishery. Currently, only one 40 foot bait dragger is in domestic operation. St. Elias Ocean Products and possibly Morpac, Inc. have expressed interest in conducting exploratory fishing to assess the commercial viability of a bottomfishery in the Prince William Sound area. St. Elias Ocean Products has indicated that

it will be bringing a couple of draggers from outside in late summer or early fall to conduct initial exploratory fishing. The primary areas of interest at this time are the offshore waters around Cape Suckling and off Middleton Island. The bottomfish resources in the offshore waters directly outside of Prince William Sound, although apparently not as large as those in the adjacent Kodiak and Kenai areas, still appear large enough to support an important fishery. National Marine Fisheries Service standing stock estimates derived from 1973 to 1975 filed operations have placed the size of these resources at:

Flatfish	37,000 metric tons
Halibut	4,700 metric tons
Roundfish	50,000 metric tons

Based on the few bottomfish surveys which have been conducted within the Sound itself, bottomfish abundances substantial enough to support a significant fishery do not appear to exist. I should point out, however, that surveys to date have been very sparse and are generally inconclusive as to seasonal fluctuations. Marine mammal feeding habit studies have indicated that walleye pollock are quite abundant within the Sound itself--the frequency with which they appear in the diet of marine mammals suggests a fairly high level of abundance. Much is presently unknown about the bottomfish resources in the entire Prince William Sound area. A better understanding of species composition, distribution and abundance as well as the determination of sustainable yield levels must be developed before this fishery can get off the ground in this area. Conflicting use problems, notably conflicts between stationary pot (crab) gear and mobile trawls, must also be resolved. Additionally, as bottomfish, whether as planktonic larvae or as benthic adults, are most oft at the lower levels of the trophic chain, additional studies need to be conducted to insure that the level of commercial exploitation is set at a level compatible with the roles of these resources in the trophic dynamics of this marine ecosystem.

The last fishery resource I would like to mention this morning is the herring spawn on kelp fishery. Although it is an existing fully developed fishery, mentioned earlier in this presentation, certain biological and political changes have occurred which will likely change the nature of this fishery. This fishery is specifically targeted at the herring spawn which is deposited on the kelp *Laminaria* sp. Present harvest methods entail hand cutting by scuba divers; although past methods predominately consisted of dragging a grappling hook behind a vessel. Recent biological data suggests that the resource is not able to sustain the type and level of exploitation that it has been receiving. I believe your next speaker, Rick Rosenthal, will be providing you with additional information on the specifics of this problem. In response to this issue, the Board of Fisheries recently adopted a 100,000 pound harvest quota for the herring spawn on kelp fishery with the additional stipulation that future harvest shall occur in areas not

already subject to past harvesting. In essence, this will sharply limit the existing fishery--with the additional stipulation--this fishery could largely fade from existence. Several methods of harvesting this resource in a more biologically sound manner have been proposed. One of the more serious of these proposals is that of the herring pound. In this type of a fishery herring are entrapped in a herring pound or enclosed and are allowed to spawn on an artificial or carefully regulated substrate; thereby eliminating the natural kelp beds from the fishery. Canadian researchers have been experimenting with this form of fishery using the kelp *Macrocystis* sp. Fairly good levels of success have been encountered with this method. How this method would work in Prince William Sound or how it would adapt to using the kelp *Laminaria* instead of *Macrocystis* remains to be investigated. Additional studies are needed in order to maintain this existing fishery.

The final topic I would like to address this morning is that of multiple use conflicts. Until recently, resource use conflicts in the Prince William Sound area have been relatively minor. However, with the recent rapid expansion of human and related natural resource development in the Prince William Sound area, conflicts of this nature can be expected to increase. In brief, resource use conflicts presently are occurring with the increased recreational use of the Sound. Fly-in operations to the outlets of major lakes and streams during the peak of salmon spawning migrations are often putting too much fishing pressure, often illegal pressure, on salmon stocks during this critical phase of their life history. This type of use conflict can be expected to increase as boater and fly-in access to the Sound increases. Increased surveillance and regulatory measures may be needed to alleviate this problem. Proposed logging operations in Prince William Sound, with their potential degradating effects on spawning stream habitats and the nearshore marine areas used for log rafting or barging, must also be carefully monitored and evaluated. Potential placer and sea floor mining operations in the Sound must also be evaluated for their impact on terrestrial and marine fisheries habitat. A great deal of discussion has centered for the past several years over the possible deleterious effect of an oil spill from tankers utilizing the Sound as a corridor for transiting to and from the Trans Alaska Pipeline terminal in Valdez. Some studies have been conducted in the Port of Valdez, but to date, little is still really known of the probable impacts of an oil spill in this particular marine ecosystem. Risk analysis, trajectory modeling, current studies, and a complete evaluation of the probable impacts of massive and chronic low level hydrocarbon pollution at all levels of the trophic system are needed. I understand that the Coast Guard is currently working up a risk analysis for use in the event of an oil spill from a damaged tanker--with the intent being of finding a location to contain this spill. Information is needed from all aspects of the research community to help insure that the biological needs of this marine ecosystem are completely presented.

Much more could be said concerning the vast array of potential use conflicts that could and may develop in the Prince William Sound

area. These are probably best left for our workshop discussions. The point I wish to leave with you this morning is that although many fish populations are capable of adapting and adjusting to a great many of man's activities, the integrity of their habitat must be maintained if we are to preserve the variety and abundance of our present populations. Conflicting resource uses, which pose a threat of long term alterations to the natural habitat, should be analyzed methodically, in depth and with a critical eye to the perpetuation of the Sound's terrestrial and marine fish resources.

SUMMARY OF THE MARINE PLANT RESOURCES

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The macroscopic seaweeds and seagrasses, or macrophytes, are found throughout Prince William Sound from small estuaries or salt water lagoons to the outer reaches of the Sound along the exposed outer coast. In addition to the attached plants themselves, countless numbers of animals live within these assemblages. We know from studies conducted in other systems of the world, especially in Canada, that the macrophytes are extremely important in terms of coastal productivity. They contribute more biomass or organic matter than the plankton, and in some cases produce up to 1,750 grams of carbon per square meter.

So it can be concluded that the base of the food chain in Prince William Sound is composed of the seaweeds and seagrasses, and, therefore, should be considered a detrital ecosystem. There is a tremendous amount of interaction between the sea and the terrestrial habitats of the Sound. For example, the blacktail deer is highly dependent upon seaweed stocks especially during severe winters.

In terms of user conflicts, we currently have a new fishery that developed in Prince William Sound during 1969, and this is the kelp fishery. It's not directed at the seaweeds themselves but the herring that spawn upon the vegetative substrates. The product is sold in Japan. It's called *Kazunoko Kombu*. It had a first value to the harvesters of about $400,000 during the past year, with a retail value in Japan somewhere around 10 times that amount, maybe $5 million.

As you may already know, there are some potential conflicts associated with this marine resource. The problems are both biological and political. The fishery during it's inception was a grappling hook fishery, or a surface fishery. On the left-hand portion of the slide you can see the harvester dragging a grappling hook along the bottom. Biologists felt the fishery was not specific enough, that there was damage to the seaweed beds. Therefore, it evolved into a handcutting or direct method of harvest using divers. This is the way it currently reads in the law. But as we stated earlier, it is a very difficult fishery to manage and there are a lot of questions still unanswered.

In terms of past and present research in Prince William Sound--let me back up a minute. Research on the seaweeds began as early as 1913 when George Rigg surveyed the seaweed beds of southwestern Alaska. His party examined some of the major beds in Prince William Sound, and even estimated the areal dimensions and tonnage available

from those beds. We are currently doing research in some of those same kelp stands. The study in 1913 was looking for a source of potash fertilizer.

Earlier it was mentioned, I think, that there hasn't been any major disturbance to Prince William Sound. There has probably not been by man, at least on a large scale. But certainly there was a natural disturbance in 1964 that affected that nearshore system, and the plant community, as much as anything the world has known. That was the great Alaska Earthquake. After the Earthquake a survey team came to Prince William Sound and conducted a postsurvey of the seaweeds in the intertidal zone. Most of the work on benthic algae was done by Dr. Johansen. Baseline information was generated from specific sites in Prince William Sound. There were some severe stresses on the nearshore zone and the associated plants and animals. Uplifts in some areas, especially in southwestern Prince William Sound approached 30 feet or more. Plants that were shoved out of the water desiccated and dried up. So we're now looking at an ecosystem that is really post-Earthquake in origin.

Other work has been conducted by Dr. McRoy and his colleagues at the University of Alaska. This has involved estimating standing stocks of seagrasses in some specific areas of the Sound. Auke Bay Laboratory carried out some OCS intertidal reconnaissance work in 1975. Additional research was done by Dames & Moore biologists on shallow subtidal seaweed assemblages in the Sound during 1975. Present research that I'm aware of continues on a small scale in the Port Valdez area. The National Marine Fisheries Service monitors some shallow water areas in Port Valdez and Galena Bay, and the Department of Fish and Game has a kelp/herring fishery project in northeastern Prince William Sound.

This slide presents some of our estimates of seaweed standing crop during the spring of 1976. It begins to give you an idea of just how productive these systems are. These figures as you can see are running around 500 grams of fresh tissue weight of seaweed per meter square. The increase over the summer follows the peak production of macroalgae during late spring. Now those figures would be low compared to some of the other areas in the world. However, the estimates are only based upon the commercially valuable brown seaweeds that occurred within the protected confines of Prince William Sound. If you were to go outside the Sound along the outer reaches and the entrances, like Hinchinbrook Entrance and Montague Strait, estimates of standing crops would be as high as 20 kilograms per meter square.

The next slide. We have done some very rudimentary work on macrophyte habitats; and there are two types that I'll be concerned with right now. They are along the exposed coastline and the ocean entrances to the Sound. This is Latouche Passage and Montague Strait, and the area that I've been studying for a number of years is called Danger Island. It's an exposed rocky coastline, an extremely robust, dynamic ecosystem. Here we find kelps from the splash zone down to about minus 30 meters and some of the band will

extend maybe from 50 meters in width, the seaweed/seagrass band, to as much as four kilometers off shore, depending on the bottom contour and depth. Most of the seaweeds in the Sound are found attached to rocky substrates, especially in exposed areas, however seagrasses are typically found in more protected habitats on a bottom dominated by silty-sands and gravel.

The intertidal area along the exposed outer coast is as complex as the shallow subtidal, and in this tide pool on an intertidal bench off Latouche Island, you can see the multitude of plants, both seaweeds and surf grass *Phyllospadix*. This particular seagrass was one of those that was affected and coated by oil during the Santa Barbara oil spill. Next slide, please.

This is the exposed outer coast, with floating beds of seaweeds or stands of kelp that even the casual observer or passer-by in a boat notices. The dominant seaweed that floats or grows to the sea surface in Prince William Sound is bull kelp, and this is *Nereocystis*. We have a few large beds in the Sound, especially in the outer reaches. If you were to put your head in and dive below these areas, you'd see these plants growing in at least 60 or 70 feet of water. It's an annual, with peak growth during late spring and early summer.

The macrophyte system on the outer coast is a system of canopy layers with sometimes up to four or five layers of plants. One could compare it to a terrestrial forest. You're also dealing with coatings and layers of invertebrate life. Next slide. These crusts come in a variety of forms and colors from coralline algae that look like corals, to encrusting or crustose growth forms.

This next slide was taken in Constantine Harbor, an area that is in line or in very close proximity to the tanker route. Constantine Harbor is a very quiet, protected environment. It contains a variety of seaweeds and seagrasses.

In the protected intertidal zone, we frequently encounter scenes like this where the beachline is dominated by rock weed or *Fucus*. So the importance of the seaweed assemblage is not only to provide carbon but also spawning and attachment sites for many nearshore species, thereby harboring or concealing both developing fishes and invertebrates. These acres and acres of rock weed are a common scene in the more protected habitats of Prince William Sound.

Also in the protected areas of the Sound are beds of ribbon kelp. That's one of the common names for *Laminaria saccharina* which is a commercially valuable species that is highly sought after if the herring spawn upon it. It's not the only substrate that the herring spawn on, but it's the one that brings the highest market value at this time.

Next slide. This is eelgrass, *Zostera marina*. We don't seem to have the extensive beds or meadows that you might find on the

Alaska Peninsula, such as at Izembeck Lagoon, but there are numerous small patches and beds scattered throughout Prince William Sound. Especially, around the mouths of creeks and small rivers. The eelgrass resource is certainly an unknown commodity in the Sound, and this is one of the plants that we should be concerned about. Next slide, please.

The seaweeds, as I mentioned, provide living substrate for other species. One of the animals that attaches to the plants is a very small filibranch mussel, *Musculus*. It is an important food item throughout the nearshore food chain. From what we've been able to determine, it is eaten by a variety of predators from sea otters to starfish. There are high densities of *Musculus* in Prince William Sound, especially on the outer coast and in the ocean entrances.

Another obvious role of the seaweed resource is to provide food for the herbivores such as this very small microherbivore, *Tonicella*. It feeds by licking the substrate. Next slide.

The seaweed/seagrass resource also provides concealment for many commercially valuable species, and here a pair of Dungeness crabs are clasping or mating, feeling they're concealed; except my camera was able to photograph the happy couple. Next slide.

Here, another commercially valuable species, the king crab, rests on sieve kelp or *Agarum* in sheep bay, which is just northwest of Cordova. Next slide. There are a number of other ways that the resource is broken down and then ultimately consumed by the system. One is by detritivores, and these sea cucumbers are grazing and dusting the substrate, breaking it down so that other components of the system can utilize it for food. The sea cucumber is probably going to be harvested in southern Alaska in the next year or so. There are some harvesters interested in them, and there's a world-wide market. However, it appears to be of minor numerical abundance in Prince William Sound. Next slide.

Some of the other organisms that live within the seaweed beds during the summer and winter are the many species of bottomfish. This is the rock greenling which is a common, conspicuous fish on the outer coast. It inhabits shallow water kelp stands.

The shallow waters of the outer coast appear to be more stable in terms of fish distribution and abundance on a year-round basis compared to the more protected areas that seem to be almost devoid of fish life during the winter. Possibly, this is due in part to the break down of the macrophyte beds through natural degradation, shedding processes, falling water temperatures and high incidence of storms.

The protected seaweed or macrophyte assemblages are almost devoid of fish life during the winter; but teem with life during late spring and summer. Most of the commercially valuable species as well as their prey items and competitors for food are found in those beds in the shallow water areas. Next slide please.

There are other species of commercial importance, one the red snapper or yellow-eye rockfish, *Sebastes ruberrimus* is highly sought after in the North Pacific. It is commonly encountered on the outer coast just below the seaweed beds. Densities are unknown at this time, and it is just one of the members of the whole suite of fishes that are poorly understood.

The importance of other fishes in the system is just beginning to be realized. One is the great sculpin. Here's a fish that we just didn't feel preyed on adult herring, however, after watching these fish during the herring spawning activities we learned that they'd hide in the eelgrass and seaweeds and then go up and take the adult herring out of the water column. I've found as many as four adult herring in the stomach of one great sculpin. After the adult herring have laid their eggs and moved off-shore, died or been eaten by other predators, the great sculpin makes the switch to feeding on the herring eggs. There are a number of other opportunistic predators that live within these seaweed beds. And this is one whose role is not well defined. Next slide.

The behavior of one animal that has been defined in some areas, and which will probably be discussed later is the sea otter. It feeds heavily in some of the seaweed/seagrass beds and takes numerous predators and herbivores that live within these beds. It certainly has a keystone position in the nearshore zone. Next slide.

Based on the surveys following the Great Earthquake, the macrophyte system appears to be resilient. However, more important than just looking at mortalities of adult plants, we should examine the substrates that these plants attach to, and the juvenile or microscopic stages. If these microhabitats are directly painted by oil or contaminated in some way, there could be grave consequences throughout the benthic food chain.

Finally, we believe there are enough people in Alaska getting the message about the value of this resource, it's as important as salmon, halibut and crab. Thank you.

SUMMARY OF THE MARINE MAMMAL RESOURCES

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In Prince William Sound there are about 20 species of marine mammals which occur with some regularity. In this discussion we'll only touch on about eight of those that are resident, at least seasonally, and are really functioning elements of the ecosystem.

The way of looking at the significance of marine mammals in the ecosystem, is looking at food consumption. I put together a few figures, biomass estimates for the eight species that we're going to be talking about on their values in the literature on food consumption rates. You multipy these all out and you come out with an annual food consumption by marine mammals in Prince William Sound of a figure approaching about 100,000 metric tons, which is fairly impressive.

Most of these marine mammals occupy a high position on the food chain and indeed are significant components of the marine ecosystem. I have some slides there, if I could have the first slide, please.

This is the sea otter. I'm sure you're all familiar with the sea otter. The sea otters in Prince William Sound, as well as most of the rest of Alaska, were exploited both by Russian and American hunters from about 1800 to the early 1900s.

Apparently in Prince William Sound sea otters were reduced to very low levels and only survived in several remnant populations.

They've been protected from about 1911, and have made a very strong come back. Some areas of the Sound have very dense populations. However, we're still seeing range expansion and animals moving into new areas and populations building up. I would expect to continue to see this for several more years.

Of all the marine mammals sea otters have the potential for being affected by oil pollution. They do not have a thick blubber layer like the cetaceans and pinnipeds do. They rely on the insulation of their fur and if coated with oil will probably suffer severe mortality. A number of the really important sea otter populations in Prince William Sound are adjacent to the tanker route. Foods of the sea otter include such things as mussels, crabs, clams, snails, sea urchins, barnacles and octopus. This is a slide of sea otters we found

in the College Fiord area. We were rather surprised to find them there. We got looking around and there are quite a number of sea otters up there. This is some distance from the main population. There are tremendously dense beds of the large blue mussel up there. We assume that that's what they were feeding on. Next slide, please.

Another one of the prominent marine mammal species in Prince William Sound is the stellar sea lion. In the interior portion of the Sound they are only found in any numbers during the winter months. During the summer they're found outside of the Sound in Hinchinbrook Entrance, Seal Rocks, Wooded Island, on the outside of Montague Island, and a couple of other peripheral hauling areas. You can see in the foreground we have the pups and most of the animals we see there are adult females. Next slide, please.

This is a winter picture taken in the interior of Prince William Sound in one of the winter hauling areas. In Prince William Sound sea lions feed mainly on pollock. Other significant foods are herring and squid. Another slide, please.

This is a large breeding rookery in the Barren Islands outside of Prince William Sound. We see an interesting change in distribution. As I mentioned, in Prince William Sound during the winter we see a real increase in population in the interior of the Sound. We have animals coming from the Barren Islands, we have them coming from Marmot Island near Kodiak, from fairly long distances moving into the Sound in the winter and leaving again in the summer. Next slide please. That's a feeding aggregation of sea lions during the winter in Prince William Sound. Next slide, please.

This is the harbor seal which is probably the most abundant year-round resident marine mammal in Prince William Sound. They are found throughout the Sound, virtually every place you go you'll encounter harbor seals. They are mainly fish feeders, pollock and herring being very important foods of harbor seals in the Sound. They utilize significant numbers of cephalopods, both octopus and squid. Next slide, please.

The most visible concentrations of harbor seals are probably in the glacial areas where they haul on ice flows that are calved from the glaciers. One of the favorite spots for viewing harbor seals is Columbia Glacier. The state ferry goes by there and you can often see harbor seals hauled out there. In the spring and early summer of the year females give birth to their pups on the ice flows as well as on intertidal rocks and certain sand and mud bars in Prince William Sound.

The harbor seal is one species that has been exploited in Prince William Sound. It has the potential for additional

exploitation. Next slide, please. This is a group of harbor seals hauled on an intertidal reef in Prince William Sound. Next slide.

Let's go on to the cetaceans. This is the Dall porpoise. It's the familiar black and white colored porpoise that we see in the Pacific Northwest. Often boaters see it riding the bow waves in front of their boat. It's probably the most abundant cetacean in Prince William Sound and is found there year-round. The main food of the Dall porpoise is small fishes. Next slide, please.

This is the harbor porpoise. It's the other common small porpoise in Prince William Sound. This species is the smallest cetacean in the Northern Pacific. Maximum length is probably up to five feet long. They also feed on small fishes. This one particular animal, which was caught in a salmon seine and drowned, had been feeding on herring and small pollock.

A couple of other cetaceans, which most of you I'm sure are familiar with, include the humpback whale, which is a baleen whale. It's found seasonally in fair numbers in Prince William Sound throughout the summer months. It was thought at one time to travel to the tropics every winter; however, in recent years we've had sightings during November and February which would indicate that at least some individuals are probably staying in the Sound.

Although it is a baleen whale, humpbacks feed to a large extent on small fishes. It's probably recognized by its long flippers, which may be as long as a third of the body length and it's also recognized as fairly acrobatic for a large whale, often seen breeching or even jumping completely out of the water. It's a fairly interesting and spectacular animal.

The other fairly large whale, a toothed whale, is the killer whale found regularly in Prince William Sound in all seasons. I'm sure you all recognize it, have seen it before. It has a large long dorsal fin with black and white coloration. The killer whale feeds on fishes and other marine mammals. Next slide, please.

This is a Minke whale, which is a fairly small baleen whale found throughout the year in Prince William Sound. In fact, it's probably the most common larger cetacean. It's about 30 feet in length maximum size and feeds primarily on small fishes.

That pretty well sums up the common and significant species of marine mammals that are found in Prince William Sound. Two other species we should mention, though they're not normally classified as marine mammals, are the river otter and the mink.

In Prince William Sound they both spend a lot of time, particularly in foraging activities, in the nearshore waters. Any kind of ecosystem analysis of Prince William Sound should also include these two species.

The next subject to be addressed is what species are currently used. For marine mammals we'd have to break it down into both consumptive use, where animals are removed from the populations, and nonconsumptive use. Nonconsumptive use is hard to quantify, but it certainly takes place in Prince William Sound with all species of marine mammals; photographers, wildlife viewers, scientists studying the animals, behaviorists, etc. And it's certainly an important use of marine mammals, particularly in Prince William Sound.

As to consumptive use, most of you may be familiar with the Marine Mammal Protection Act passed in 1972, which with a few exceptions imposes a moritorium on the taking or killing of marine mammals. Before the passage of this Act, harbor seals, and to a lesser extent sea lions, were harvested in Prince William Sound. Presently there is some Native use, under the Native Exemption Clause of the Marine Mammal Act, of harbor seals and maybe some stellar sea lions in Prince William Sound.

The state has petitioned the Federal Government for return of management authority for certain species of marine mammals. If this takes place, I would anticipate some additional harvesting of harbor seals and sea lions in Prince William Sound.

The next category we will look at is potential uses of Prince William Sound marine mammals. I suppose you might say that all biological populations theoretically have the potential for exploitation for harvest. However, we have a lot of constraints besides biological constraints, including aesthetic and political.

As I previously mentioned, harbor seals do have the potential and may indeed be subjected to increased harvest. Sea otters are a touchy subject. They certainly have the potential for harvest; however, those of you who have followed the California sea otter situation realize the problems involved. The state's plans for sea otter management do not include any public harvest. There might be scientific harvest and possibly animals removed for transplants.

Potential use of another species is the capture of live killer whales for use in oceanariums. There were problems in Puget Sound where animals had been taken in the past, and places like Sea-World, Sea Land, etc., have looked for alternate sources of killer whales, and Prince William Sound has been discussed.

Apparently, they are now being taken from some of the North Atlantic populations; Iceland and Greenland; but this is also a potential use of killer whales in Prince William Sound.

I suppose with marine mammals the major conflicts come with competition for what they're eating. Sea otters have been a big source of controversy in California. There have been problems with abalone and clam fisheries and their compatibility with sea otter competition. Sea otters are said to feed on amounts about equal to 25 percent of their body weight a day and apparently do have the potential to extensively modify the structure of their prey populations.

We had some discussion earlier in the day about potential fisheries on clams and certain other shellfishes. I haven't personally studied sea otters and I'm not really familiar with their food habits and feeding rates, but it would appear that there are probably some potential conflicts in Prince William Sound.

The other species of marine mammals we've discussed are largely fish eaters. As I mentioned, herring and pollock are two of the major prey items. Herring, of course, are being exploited at the present. Pollock, I suppose, have the potential--they appear to be fairly abundant based on food habit analysis of sea lions and seals in Prince William Sound and comparing these to the other populations, pollock is a much more important food item in Prince William Sound than other areas. So there is a potential conflict.

Pollock are presently being exploited in the Bering Sea. There are large marine mammal populations there, including the northern fur seal. Some biologists feel that there is serious competition there between marine mammals and commercial fisheries. We could conceivably see conflicts like this develop in Prince William Sound.

Other resource development, transportation or development of oil through Prince William Sound or on the Outer Continental Shelf do have some potential for conflicts with marine mammals. I mentioned the vulnerability of sea otters earlier. There's no doubt that under the right circumstances an oil spill would impose significant mortality on sea otter populations.

The effects of oil on other marine mammals are not so clear, but they could have a number of potential effects. It could affect prey species. Some of the literature shows that, like herring spawn, exposure of gravid female herring to certain components of petroleum can reduce productivity. Significant

reduction in prey species for the marine mammals will in the long run affect the population unless there is alternate prey that they can adequately exploit. This is another potential conflict.

If anybody has any questions I'd be glad to answer them.

UNIDENTIFIED: Do you have any kind of information on the kill of mammals from fishing activities?

MR. PITCHER: I don't personally have any information. There was a student at the University of Alaska who worked on the Copper River Delta last year who has some limited information on that. I don't know what his figures are. Certainly some does take place. For instance the harbor porpoise I showed in the picture was a mortality from fishing operations. Harbor seals are well known for pulling salmon out of gill nets and for mutilating salmon in gill nets, and fishermen do kill them in the course of their fishing operation. As far as numbers go I don't have any information.

SUMMARY OF THE MARINE BIRD RESOURCES

M. E. Pete Isleib
Fisherman and Naturalist
Cordova, Alaska

The state of the knowledge on marine avifauna in Prince William Sound starts off with this brief summary used in an oft quoted statement, whose authorship I cannot remember. "Birds are highly visible components of the ecosystem and are excellent weather vane indicators of the state of health and changes taking place in the system."

Beginning with this phrase, and I'll come back to it later, I'll first capsulize the history of knowledge of the avifauna in Prince William Sound. Two hundred years ago, in May and June of 1778, Captain Cook on his last voyage lingered a few weeks in Prince William Sound servicing his ships and exploring the large embayment. The personnel attached to his vessels collected the first information on birds of the region, and these data were limited to a score of specimens collected and subsequently taken to British museums.

In the following 150 years and until the 1930s only one formal publication of significance added to that data. The Alexander expedition during 1908 spent three and a half months in Prince William Sound, and Dr. Joseph Grinnel of the University of California later reported on the extensive investigations which studied the composition of the birds by visiting a cross section of Prince William Sound habitats.

During the next 40 years, the 1930s through 1960s, the knowledge of the marine birds increased dramatically due in part to more frequent visitations by ornithologists and by increasing interest shown by the U.S. Fish and Wildlife Service and later the Alaska Department of Fish and Game in managing populations of waterfowl and other birds that frequent the region.

From the perspective of history, 1970 proved a major turning point. The then proposed construction of the Trans Alaska Pipeline to a terminal at Valdez and the potential impact of oil transport operation in Prince William Sound, combined with the National Environmental Policy Act, NEPA, exposed the gross inadequacy of existing information.

Beginning in 1970 and continuing to date Governmental agencies, principally the U.S. Fish and Wildlife Service, have conducted a number of studies on marine birds in Prince William Sound. These studies began with inventories on the status of abundance

and distribution of marine birds, and are now developing into a second level of studies concerned with breeding biology and feeding ecology of several colonies of nesting seabirds.

I first became familiar with the Sound and its avifauna in 1961. I took up residency in Cordova in 1964. As a naturalist I was immediately aware of the dearth of information on the birds of the region, with the partial exception of migratory waterfowl.

By 1969 I had gathered enough data to prepare a checklist for the bird species and their utilization of the region. Dr. Kessel, then dean of the College of Biological Science and Renewable Resources of the University of Alaska, suggested that I work up my data into a more comprehensive form. In November of 1973 we published the biological paper, "Birds of the North Gulf Coast--Prince William Sound Region Alaska."[1] My participation in the U.S. Fish and Wildlife Service marine bird surveys in Prince William Sound during 1971 through 1973 greatly aided in my understanding of the complexities of the area, and I additionally gathered a volume of data that was published at that date.

Information on the status and general abundance and distribution of all birds in Prince William Sound were included in that monograph. Subsequent to 1973 considerable data had been gathered by resource management agencies and by individuals so inclined. While I consider that the information on Prince William Sound avifauna is still sketchy, it's probably better known than most other areas of its size in the state.

The following statistical data is presently available. Of the approximately 360 species of birds recorded in Alaska, two-thirds or about 240 species, have been reported from Prince William Sound and contiguous areas. Of this 240, over 50 percent or about 125 species, are primarily marine related species.

There are 88 known colonies of nesting seabirds, colonies ranging in size from a few pairs to over 5,000 pairs. Resident marine bird populations in midsummer in Prince William Sound exceed 500,000; the winter populations exceed 300,000 individuals.

Tens of millions of birds traverse the area during migrational periods twice annually. Thus Prince William Sound, lying in the migrational route of millions of birds, which breed in western and northern Alaska, is extremely important. This fact is well recognized by the U.S. Fish and Wildlife Service, the

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[1] Isleib, M. E. Pete, and Brina Kessel. In: Biological Papers, University of Alaska, No. 14; November 1973.

managing agency of migratory birds. Two departments within that agency are carrying out avian research programs in the Prince William Sound area. The Office of Special Studies has been collecting data within Prince William Sound, and the Office of Biological Services, working on OCS related programs, is conducting studies in the contiguous Gulf of Alaska.

The emphasis placed on these studies in this region are related to the concern by the Federal Government of the future health of this environment. Prince William Sound is nearly as pristine an environment as you can find in the U.S. today, probably little changed by man in many aspects since Captain Cook's voyage 200 years ago.

In my mind, the top of the trophic pyramid in Prince William Sound is occupied by both man and our national bird the Bald Eagle. In birds, the top of the trophic levels are often first to be seriously visibly affected by pollutants within the environment. Bald Eagles occupy nearly every niche in Prince William Sound except where physically displaced by man or man's activities.

The eagle population in Prince William Sound is between 2,000 and 3,000 resident birds, about 700 nesting pairs. This is roughly the same number that is currently found in all of the Lower 48 states. Additionally several thousands of transient eagles utilize Prince William Sound enroute to and from more northern and western breeding regions.

I started my brief summary mentioning that birds are highly visible components of the ecosystem and excellent weather vane indicators of the state of health and changes taking place within the system. In reference to this, with regard to the eagles, when and if an eagle becomes an uncommon sight in Prince William Sound, I believe all of us are in serious trouble.

SUMMARY OF THE FOREST PRODUCTS

Clay Beal
Forest Supervisor, Chugach National Forest
U. S. Forest Service
Anchorage, Alaska

As an employee of the agency responsibile for management of much of the land surrounding the Prince William Sound area, I'm really interested in becoming involved in this workshop and in the results of the workshop. It can't help but be useful to the Forest Service in the future.

The land ownership around Prince William Sound in the past has been pretty much solidly National Forest Lands, but that ownership pattern is changing, as I'm sure most of you know, as the result of the Alaska Native Claims Settlement Act and as the result of the Statehood Act. This past solid National Forest ownership will become a mixed ownership.

The Chugach Forest is currently involved in a land management planning process in which long-range direction is set for the management of the National Forest land and in which allocation of certain lands for certain activities is made. In developing such a plan we are involved with going to the public and getting any kind of public information or public input from those who are affected by what happens in the Sound as far as these activities are concerned or what sort of activities are allowed on the National Forest land. So, a workshop such as this is extremely helpful.

The Forest Service is an agency that has been directed by Congress to administer National Forest lands for a variety of uses. Even though this says forest products (and most of you are probably thinking I'm here to talk purely about trees), Congress specifically directs us to get involved with a lot of other things not only the timber, but also the wildlife, the water, the recreational uses, wilderness and minerals. We consider all of these things as forest products. Because of this I'll be touching briefly on a variety of products rather than purely the timber resource.

It should be kept in mind that the regulations that direct the Forest Service provide that any kind of permanent occupancy on National Forest land or any kind of a use of National Forest land for a commercial venture must be approved by the Forest Service and must be under a permit.

I've brought along some of our work maps and overlays; I think they'll be helpful. The base map shows the land ownership, the

Native selections, not only the village selections but also the proposed regional selections, and the cultural and historic selections, which are fairly numerous in Prince William Sound. The base map also shows the nominated State selection areas.

One of the overlays I brought along shows the occupancy, recreation cabins, recreation residences, and navigational aids that are under permit to the Coast Guard.

Another one shows the wildlife and fisheries resources as we know them in the Sound. It shows where the different species of upland wildlife occur. It also shows the existing and potential aquaculture or fisheries enhancement projects or sites where these projects could take place; to the best of our knowledge, the potential development sites.

By aquaculture I mean things that are really fishery improvement projects. This might mean barrier removal from a stream; it might be the installation of a fish ladder to a hitherto unaccessible portion of a stream, or it might mean a hatchery site.

We need a lot more data as to where these potential facilities can be placed, and we work very closely under a cooperative agreement with the Department of Fish and Game in identifying these sites. There is a lot more work that needs to be done.

Another overlay I've brought along shows the mineral zones. Someone else will be talking more about the minerals. It also shows the known mining claims that have been located in the Prince William Sound area.

Another overlay shows the commercial forest land within the Sound area. Finally, we have an overlay that shows the proposed wilderness area within the Sound area. Many of you are probably familiar with H.R. 39 and the proposal for a rather large wilderness and wilderness study area called the Nellie Juan Wilderness Area. It includes the Sargent Ice Field, the Nellie Juan area and most of the Sound east to Valdez Arm.

The administration's position, which we support, includes a wilderness of about 690,000 acres that includes the Sargent Ice Field and the Chenega area, the old proposal that we've had as a wilderness for some time. It also includes 840,000 acres that lie in College Fiord up into the present public domain north of College Fiord and loops back down into the Prince William Sound area around Columbia Glacier. Then the area in between those two proposed wildernesses is wilderness study area, and that's another 450,000 acres or so.

Now, just a brief overview of the forest products in the Sound. We consider the recreation, scenic and wildlife or wilderness resource as one of the key forest products in Prince William Sound. Since Neil Johanssen will be talking about that I won't say too much about it. The overlay that I've brought shows both the occupancy, some of which is related to recreation, and the proposed wilderness designation and study area.

I might say that our national direction from Congress is to increase dispersed recreation. It isn't development for dispersed recreation, but it's to increase dispersed recreation in the National Forest system. Within the Prince William Sound area, dispersed recreation is the kind I expect will occur.

I mentioned an overlay on fisheries. We consider the fisheries and wildlife values also as key resources in the Sound. These have already been discussed. There is a lot more work that needs to be done and a lot of cooperative work with Fish and Game, both in fisheries and in wildlife.

The timber resource in Prince William Sound has been utilized to some degree for the past 50 or more years. And there are active timber sales operating in the Sound at this time. The overlay that I've brought shows where the commercial forest land lies. Generally, the area contains two major commercial timber species, western hemlock and Sitka spruce. This is the northern limit of both of these species. Currently the utilization of commercial forest products fits into about four different categories. The first is for cant production for the export market. The Forest Service requires that timber harvested in Alaska from the National Forest be primarily manufactured in the State. This means that it must be canted; that is, it must be eight inches or less in thickness or it must be converted to pulp. And the export market is where the cants end up. Currently both Southcentral Timber Company and Louisiana-Pacific have operating sales that are producing cants.

The second commercial forest product is the chip manufacture taking place in Seward by Louisiana-Pacific. Third there is currently some timber being harvested for lumber manufacture for the local Alaska market. United Lumber Company has some timber sales that produce lumber for the local market.

Last but far from least are the timber needs of the local people; that is, personal use from small sawmills in the localized community.

I suspect that the forest products industry in Prince William Sound will continue to operate on a rather opportunistic basis. The mill capacity adjacent to the Sound is about 30 million board feet, and that's considering that some form of primary manufacture will be required.

The Native corporations, which have selected considerable acreage within the Sound, are not presently bound to any type of primary manufacture regulations. This allows them to react more quickly than the Forest Service to the world market conditions as they change.

Some of the factors that I think might affect timber harvest opportunities in Prince William Sound follow. The current overproduction of pulp mills world-wide is predicted by various sources to be stabilized in the early 1980s. The demand world-wide for timber products will increase. Export policies in the Lower 48, if changed, could affect the Alaska timber harvest; that is, the availability of dimension lumber from the Lower 48, could be reduced, making Alaskan timber a much more desirable product for manufacture here in the State.

Another factor is the ability of local forest industry to establish and retain control of interior lumber markets rather than importing from the Lower 48 and Canada. There is a considerable timber resource in interior Alaska. If it becomes more available, it would affect the timber harvest in Prince William Sound.

The management options selected by the Native corporations in relation to utilization of their forest products and whether or not they opt to export would affect the timber in the Sound. How much of Prince William Sound will be designated a wilderness or wilderness study area or how much of Prince William Sound will be designated multiple-use land, in the long run will affect just what kind of activities take place there.

Certainly timber harvest presently conflicts with the wilderness resource. I've mentioned the present administration's position on wilderness. There's some conflict, as was mentioned earlier, with fisheries. I think that the past conflict with the fishery resource in Prince William Sound has been more of a conflict over hook points, log transfer sites and anchorages than it has been any other type of conflict. There hasn't been a great deal of conflict in Prince William Sound compared to other parts of the state, Southeastern in particular. There hasn't been a great deal of logging activity taking place in the Sound, although it has progressed over a great number of years. More often the logs are required to be barged rather than rafted, and this has tended to alleviate that conflict.

There is also the conflict between the scenic resource and the harvesting of the forest products which affects the landscape. For 20 or 30 years there's a definite impact on the natural landscape features until the stand canopy closes.

I think that increased utilization and advanced logging systems would go a long way toward alleviating some of these conflicts. There's also the possibility of some sort of a selection system

of harvest, which is possible but which is very expensive. The problem with all of those options is that they increase the development and harvest costs.

One other forest product that I want to mention briefly is the minerals resource, the subsurface resource. I'm sure the next speaker will talk about the mining history in Prince William Sound. It's a rather lengthy history, too. There's been considerable history of mining activity in the Sound in the past. The present mineralization of much of the area will lead to much speculation on just what impacts could result. The Forest Service considers the mineral resources as an important product of the National Forest and historically has worked with the industry to wisely remove the products in a manner that is compatible with the other resources in the area.

The overlay that I mentioned earlier shows the mineralized zones and it shows the locations of existing mining claims in the Prince William Sound area.

I think this covers forest products. I look forward to the workshop being helpful to all of us. Are there any questions? Yes, sir.

UNIDENTIFIED: Normally a wilderness area precludes motorized traffic in the area. And I was wondering if there would be any difference in Prince William Sound since this is a salt water area?

MR. BEAL: If the area were designated a wilderness, it would not affect the salt water. There's a question about past use of motorized equipment for lake access, specifically the use of float planes in wilderness areas in Alaska. A great deal of discussion has gone on over this in the past six months to a year. It will depend on just what the legislation says. There's one group that feels that this should continue to take place within wilderness where it's traditionally taken place. Another group feels that wilderness should be extremely pure and there should be no motorized transportation. Those kinds of things haven't been resolved yet. Some people feel that there's enough flexibility within the Wilderness Act to allow these things if they're necessary. I'd say that the legislation will specifically speak to that. That also includes the conflict of wilderness over fisheries or fisheries enchancement.

SUMMARY OF THE WATER RESOURCES

Robert Carlson
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University of Alaska
Fairbanks, Alaska

The fresh water of the coastal zone is usually "obvious" yet is often taken for granted. It rains a lot, it is cloudy, and one never gives much thought to it. Nevertheless several characteristics of a northern coastal area bear attention; I will try to describe those as they apply to Prince William Sound.

Being adjacent to a marine area, the hydrology is dominated by long periods of rain or snow. Being a northern area, much precipitation occurs as snow and is stored until spring. This creates three distinct seasons; a spring breakup season in which much of the snow melt is released, a summer rainfall season with summer rainfall runoff and snowmelt from higher elevations, and a winter season characterized by a few rain storms, and slowly declining flow. This flow may become very low for some activities in January, February, March and the beginning of April.

Prince William Sound is somewhat peculiar as it is characterized by a group of relatively small basins. There are no really large rivers if you leave out the Copper River which is out of the Sound proper. I will briefly mention some numbers which I have gleaned from the literature.

There are very few waterways that can be called rivers, most are small streams, a few lakes, quite a bit of wet lands, and intertidal zone and some ground water supplies. The previous speakers alluded to the use and exploitation of the resource. Water is used very locally for city and industrial water supply and salmon enhancement activities.

Little opportunity to move water from one place to another exists. The topography doesn't lend itself to extensive transfer of water conflicts, but when they occur they will be very local. Another part of the water resource which is not very well understood is the effect on the marine environment through providing a fresh water flow to the near coastal zone in the spring and summer. If a study program is undertaken, this fresh water effect should be a very important component. About 8,000 square miles of drainage area exists for fresh water runoff potential. Precipitation varies between 60 inches in some of the islands near the Gulf of

Alaska to nearly 200 inches in the very high elevations further inland. Snow accumulates in amounts of 50 to 150 inches.

One characteristic of a coastal area is the extreme lack of regional homogeneity and disparity in precipitation and snow amounts and therefore runoff. Generally, precipitation increases from the coast to inland and the very high snow fields. Much of the coastal zone proper is dominated by glaciers and therefore has a snowmelt that lasts throughout the summer melt season.

The geologic environment is important to understanding coastal hydrology. The topography ranges from about sea level to 12,000 feet with a great number of massive glaciers. Most islands are less than 1500 to 2000 feet. The bedrock is mostly of a crystalline and sedimentary nature. Some alluvial deposits exist next to the major streams. As a result ground water sources will be very limited and there will be little opportunity for ground water recharge from streams or lakes. Runoff is fairly high, between 4 to 12 cfs (ft^3/sec) per square mile, an average value for the coast of Alaska. Peak flows range between 100 to 300 cfs per square mile and low flows are 1 or less cfs per square mile in the wintertime. These values indicate a variability from over 100 times from the low to the peak flows. The fact must be carefully assessed when estimating dependable water supplies. The rivers for the most part are very short and steep and therefore in combination with rocky slopes have a very fast runoff response to rain storms and snow melt. Because of the rocks, the rather sparse vegetation and the very steep slopes, little natural storage exists. Few drainage areas are greater than 100 square miles.

Quite a number of lakes exist in both the coastal area and on the islands. Few are greater than 10 square miles. The ground water, as mentioned, will be mostly poor when it can be found and will lend itself only to very limited supplies.

A few hydrologic features of the Sound could bear a closer examination. Here's a plotted elevation of Power Creek near Cordova. The elevation rises very abruptly and because most precipitation measurements are taken at sea level much of the upper elevation area is not really measured yet, and this is where most of the snowmelt and some rainfall runoff occurs.

An important water resource for this water supply and the marine ecosystem is the stream runoff. The Power Creek streamflow data from a very small basin near Cordova, again illustrates key features of basin runoff. It is one of the few streams measured in Prince William Sound. There is a

great variance of flow, almost 500 times from the wintertime to the summertime. The winter season exhibits a very low flow, followed by spring snowmelt, which lasts quite a long time. A few summer storms runoff in addition to the snowmelt.

Because of the very small drainage basins and the snow accumulation, there is a season of the year which is very wet with not much fresh water coming into the system. Also, again illustrated by Power Creek, a large year to year variability may exist. In any attempt to utilize the water supply, the year to year variability of flows will have to be carefully assessed. Flow also varies seasonally with low flows in January, February, March, April and high flow from May, June, July and into November. It would be very dangerous to make a stream flow measurement for only three years and consider that as a basis for a dependable supply.

Another important feature of the fresh water input is sediment discharge. There are no good records for Prince William Sound except the Copper River, which is outside the Sound proper, but indicative of the kind of sediment discharge which may be present, especially in the glaciated areas. There is practically no sediment discharge in the winter months but then a very high rise in May, June, July, August, and September as the snowmelt comes off of high elevations. Sediment input will be a critical feature of a marine ecosystem analysis. The main present water use is for municipal supplies. Cordova uses a surface water supply and has a distribution system. Valdez and Whittier apparently get their water supply from wells because of their location in an outwash area and have distribution systems. Besides furnishing the water supply for residential and commercial use, it also furnishes a waste transport system and carries away domestic waste to a treatment process. Practically all other water supplies are from individual wells.

An important future water use will be for fisheries habitat enhancement activities, both for hatcheries and natural habitats. It seems that much of the difficuly that the fisheries habitat had in the past came from a lack of sufficient water supply. For future resource development there will quite likely be an increased use of water for hatcheries, oil refineries, terminal facilities and food processing. Mining activity would also need a water supply.

Water management will be difficult as the water is found very locally and very seasonally. Little opportunity will exist to transport it from one locality to another.

Water conflicts will be quite local mainly between the demand desired and the supply provided by nature. There

will be attempts to use lake water for hatchery purposes or municipal and industrial supplies. Attempts to draw down lakes could cause a conflict if the lake provides a habitat through its wet lands and marshes for other purposes and attempts to raise the lake level may also disrupt local environments. Again, these conflicts would tend to be quite local in nature and would not necessarily be wide-spread throughout the region.

Water will always be a part of man's activity and man will have a problem with it. Water will not be there when he wants it, in the place or the time he wants it, and so he must build something in which to save it until he needs it. Water will continue to provide a transport mechanism for many of the processes in the marine ecosystem.

SUMMARY OF THE NON-RENEWABLE RESOURCES

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In looking at the mineral resources, the suite of hard minerals, both lode and placer, the sand and gravel possibilities and oil and gas for the area as a whole, I think we can come to see, using just a quick bit of science, that we restrict the non-renewable resources very quickly.

Considering the geological terrains of the greater Prince William Sound area, including what's known of the offshore rocks, we note that the basal units are essentially an older geologic section that provides for the interests of the industrial and geological people here. It is essentially a late Paleozoic to Mesozoic section, and essentially a crystaline facies. They are hard rocks, very hard rocks; mica, schists, volcanics, and in the metamorphic grades, commonly amphibolites. A middle section, essentially defined as Mesozoic, but dating is still questionable, again metamorphic in nature, of metasediments, volcanics and volcanic clastics and with some considerable structural deformation in the area. And lastly, an uppermost section of rocks and some unconsolidated sediments, probably Tertiary Paleocene through Pleistocene topped by a very thin veneer, in places, of Recent modern sediments. Some of these are marine clastics and, as such, brought early attention to the petroleum industry, although many units are now known to be terrestrial sediments.

Throughout the upper range of rocks, reworked glacial sediments are common. The scene of a high latitude depositional site that has been common in the area since middle Tertiary time. It's this reworking (metamorphism, erosion, etc.) that has provided for economic concentration of some considerable amounts of the noble metals in the area.

Just as an example, I mention areas that you may know by name in the Valdez quadrangle: placers at Gold Creek, Mineral Creek, Solomon Creek, all have long history of small mining activities, lode deposits in the Bly Island area, the Cloudman Bay area; and a very important deposit worked commercially for copper for many, many years is at Ellamar, near the Tatitlek Narrows Indian site. Other mines in the area are at Banser, Fidalgo, Wilson Point. These are, or were, commercial. Most of these are noted on the forestry charts. An interesting site in the Cordova quadrangle for placers is in and around the

Bremmer River. Little known is the potential placer on Middleton Island and marine sites offshore from Middleton Island.

Now, so that we have material to take to the section workshops, we have distributed hastily-done handouts; we might take a second to look at these. This first chart, #1, Placer Gold Mines and Prospects in and around the Prince William Sound area. The series of dots or circles with numbers indicate known prospects, economically viable deposits or workings, and you'll notice that there is a ring, a structural ring, of these sediments that produce placer gold in the area. I present these mainly as an index of mineralization in the greater watershed area of Prince William Sound.

To come to the point of a bit more specific information, and as examples, look at chart #2, Lode Copper and Placer Gold. This map is for both metals--it mainly shows marine, but it also suggests some possibilities of production on the shore. Ellamar (in the very center of the chart) produced copper, considerable amounts of copper, from the period of about the turn of the centry well into the 1920s and 1930s. It was finally abandoned as a copper producing property not because of reserves, these are projected and some proven, but rather because of water flooding the mines there, and at that time, technology did not allow for mining beneath the sea. Some tunnels, of course, did go under what would be the Tatitlet Narrows water, but if you'll notice there is a definite projection of the copper trend seaward from Ellamar. This projection is based on geo-chemical data, unpublished and published, and some proprietary discussions with people in the mining industry. The important point; the copper deposit extends seaward beneath the waters of the Sound. If it is mined as an underwater deposit, the question will be: how and to what extent it will be mined through the sea floor?

A very well mineralized area with very good geochemical halos as mineral indicators is in the Galena Bay area just to the north of Ellamar. In two smaller bays, gold anomalies are already reported for West Bay and Bligh Island and down around Cloudman Bay on Bligh Island. On the land itself, there is certainly a possibility of lode deposits of both placer gold and lode copper.

Let's look at chart #3, Potential Marine Mining Sites in the Upper Valdez Arm area. These sites were brought to my attention two or three years ago by Mr. R. M. Thompson. We've seen some unreported data on the area, but off the "mineral delta", as it were, of Mineral Creek, there is good potential there for both buried Pleistocene beach ridges (now covered by a thin veneer of sediments) and for some reworking of modern gold-bearing sediments coming down the Mineral Creek drainage complex. Again, over by Old Valdez another major intradelta that appears

to have the possibility of buried ridges, beach ridges deposited during the Holocene lowering of sea level, are present as a productive site, and gold is known to be carried to the sea in this area.

The whole trend of the arm side near Sawmill Creek is a potential gold area, and while our time does not allow us to discuss it, there is some thought that currents of past lower sea-level concentrated even the small introduction of gold during the entire middle Tertiary through late Tertiary time, and well into the Pleistocene or Ice Ages. Such gold is now concentrated under a thin veneer of marine sediments.

We might look then at the last chart, #4, taken directly from a U.S. Geological Survey publication of about 10 years ago; as I recall, Von Huene's work. You'll notice that there is gold on the beaches from well beyond Cape St. Elias all the way up to Hinchinbrook Island. The survey was stopped at that point not because they ran out of good gold indicators in the beaches but because of a budgetary constriction that the Survey had at the time of that survey.

Of interest, if one goes to the literature, the Russians produced gold in the beaches at and around Katula Bay as early as about 1850-55. Thus, there is a long history of beach gold production. Now for what gold one sees in these modern beaches, there is, likewise, appreciable gold concentration offshore of them. Von Huene--I think Arnold Bouma has also commented favorably on this area, and colleagues that I've spoken to in industry, suggest very strong possibilities that this beach gold trend likely extends right on up into Prince William Sound, with some of the gold deposited at a lower stand of sea level. This circumstance means that the probable gold production would not be right up against the shore, but would begin something in the order of a mile offshore and beyond, depending, of course, on the depositional framework. Of interest in looking at this whole picture, and it might be of concern to those of you in other workshops, the Chugach/St. Elias fault system that surrounds this area is a good natural divider geologically, hydrographically, and in many other ways, and the rules of the game and study might be to look at what occurs on either side of this fault system.

In looking at the offshore mineral exploration, I would comment that the three-mile tidal waters are locked-in and held firmly by the State of Alaska under a very carefully prepared state constitution and statutes promulgated shortly after statehood. The questions of offshore prospecting permits in the first three miles, who owns that three miles, challenges and claims to it have never been contested, which means that State of Alaska offshore prospecting permits are sound. As a matter of fact, they're not restricted just to industry or entrepreneurs.

Any one of you could go down to the Alaska Lands Division building and, for $20 and 10 minutes of your time, fill out a form that would give you up to 2,400 acres of underwater real estate (state lands) to do with as you like in terms of mineral exploration.

The general trend of mineral deposits is most likely to be parallel to the coastal bend of the Prince William Sound area. North of the fault that I mentioned, we can expect rugged crystalline rocks and some considerable mineralization. South, or on the seaward side of the major fault trend, are bedded, slightly-less-metamorphozed rock--some not metamorphosed, of course--with small igneous bodies. All-in-all, a desirable mineral exploration area.

I'd say that, within the coastal zone of all Alaska, Prince William Sound stands second to the Seward Peninsula and just ahead of the mineral area between Petersburg and Ketchikan, which is now undergoing intensive mineral testing with very favorable results already.

Let me summarize the key points. In looking at the petroleum possibilities within Prince William Sound, *per se*, frankly there are none. For those of you who might be concerned with oil platforms in Prince William Sound, I think you'll never see them. Unless we're fooled by some mighty complex geology, or there are new discoveries in deep geophysical work, I don't think the type of source rock, the type of structure, and the type of reservoir rock--they're very tightly packed rocks--are present.

The hard minerals, though, are an entirely different matter. As I mentioned, Prince William Sound is a very promising area, both submarine; that is, below the sediment/water interface, and on the beach as placer deposits and as hard rock, lode deposits beneath the sediment/water interface, the prospects look very good. In a recent discussion with people that have more data than I do in that particular area, both on land and offshore, and in considering the commodity metal problems up to that point--also considering external economic problems related to the United States and the dollar balance--and considering 1990 dollars, the probable projected *in situ* wealth in minerals in the greater Prince William Sound area will be--judged on the best estimates we can make at this time--about $750 million.

The types of metal targets--this will concern those of you considering waste effluent problems--will include copper in the Ellamar area, and perhaps at other sites in the Knight Island complex. These are proven targets. Gold is apt to be, and continues to be, an actively sought mineral as the success at Nome in recent years has much encouraged new investment and new capital in Alaska. There's also renewed vigor in the price of

gold, at $183 per ounce, I think, on yesterday's market. We see all this as a positive trend.

Aside from gold and copper, and illustrating the cycle of mineral resources and environmental concerns, two space-age minerals, are holmium and palladium. Two of the best places under the U.S. flag to look for these are in the area around Good News Bay and in selected areas in and around Prince William Sound. Holmium is a new "wonder metal," considerable promise for greatly expanded industrial use. Palladium, I might say, appears to have greater catalytic properties in its use in catalytic converters for automobiles, than even platinum has. (We've recently closed the last platinum mine under the U.S. flag.) So palladium, as a critical component metal in each one of those catalytic converters on every car to come out of Detroit (if the anti-pollution rule holds) means that we will have to look for a hell of a lot of palladium and platinum as well. Considering that the present sources of palladium and platinum for the United States are Russia and South Africa--one nation not exactly the acme of friendly feelings and the other one somewhat politically unstable these days--we might do well to look here in Alaska. But the trend, from mining the palladium and platinum here, taking it back into the cycle of converters to make Los Angeles and Detroit fun places to live, does indeed make for an interesting ecologic-economic cycle.

The other conflicts, though, are straightforward. Where do we see these? If the Prudhoe Bay field holds out and the projected production that ARCO tells us about is real, over the long haul we'll see about three decades of oil coming down the Pipeline. That means there will be a lot of tankers going in and out.

Where we see the problem here would be that the tankers--the size they're coming to, they're hard to put brakes on--and the lonesome dredge or hydraulic system that's tied to the bottom while working offshore and that can't move out of the way, does make for a possible navigational conflict. However, an alert Coast Guard, proper buoy systems and good radar control, and the other new magic communication systems that the Coast Guard has on the drawing board, much reduces the chances of this conflict point.

The other conflict is with the fishing industry. Obviously, seafloor mining operations are not all that quickly moved, and there can be problems in changing the character of the bottom, as well. In fact, some bottom draggers may be much concerned with changes in the bottom. Not all changes, but some changes. In terms of the salmon runs, one feels that cooperative understanding will prevail; marine mining, should it come, could be temporarily stopped during periods of salmon runs.

I'd say, in looking at--not the exploitation phase, which is still many hurdles to jump, but looking at the exploration

phase--the at-sea operations will consist of passive techniques; towed magnetometry, towed high resolution acoustic profiling, geochemical sensors placed on the bottom and recovered later, and applied physical and chemical oceanographic measurements.

The mining of resources of sand and gravel for construction purposes will be handled locally, i.e., at convenient sites near communities. This may be administered under the purview of the State and I do not see sand and gravel mining becoming a major environmental problem. There's just so much gravel and so much sand that the relatively small communities in the area could use, or will need.

Thank you. Are there any questions?

MR WENNEKENS: Yes, on your map showing the anomalies on the Copper River Delta, there are no limits, I understand. How many cubic feet of sand do you have to process to get an ounce of gold out there?

MR. MOORE: This on chart #4?

MR. WENNEKENS: Yes.

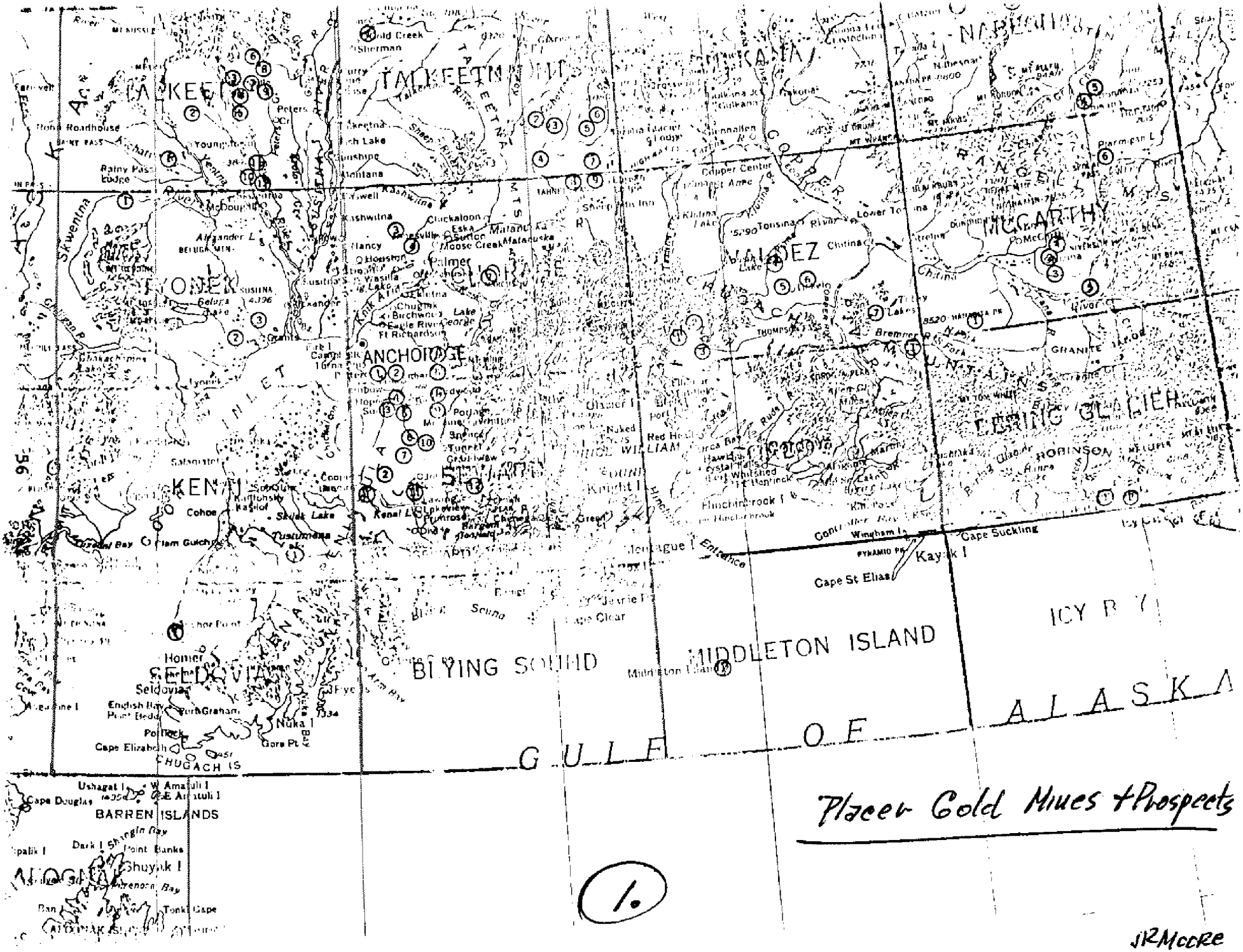
MR. MOORE: All right. At the present price of gold, you might produce on most of these, the production of gold would be somewhere around--well, it varies, but somewhere between 20 cents to the ton recovered to probably $1 per ton. What happens on the beach prospects, they're usually worked by Herman and his brother and his wife and their two kids doing this job, and it's a very "hot spot" type production, not the whole beach face. They'll produce the richest stuff first. The record of production from those high-land beaches is, I think, a total production to-date of something in the order of 20,000 to 50,000 ounces. Most of that at the price of gold prior to 1934, which was, as I recall, $20 an ounce.

MR. WENNEKENS: No, I'm saying how much volumes of material you have to process to get one ounce of gold.

MR. MOORE: As a general for this whole thing to be processed?

MR. WENNEKENS: Based on this.

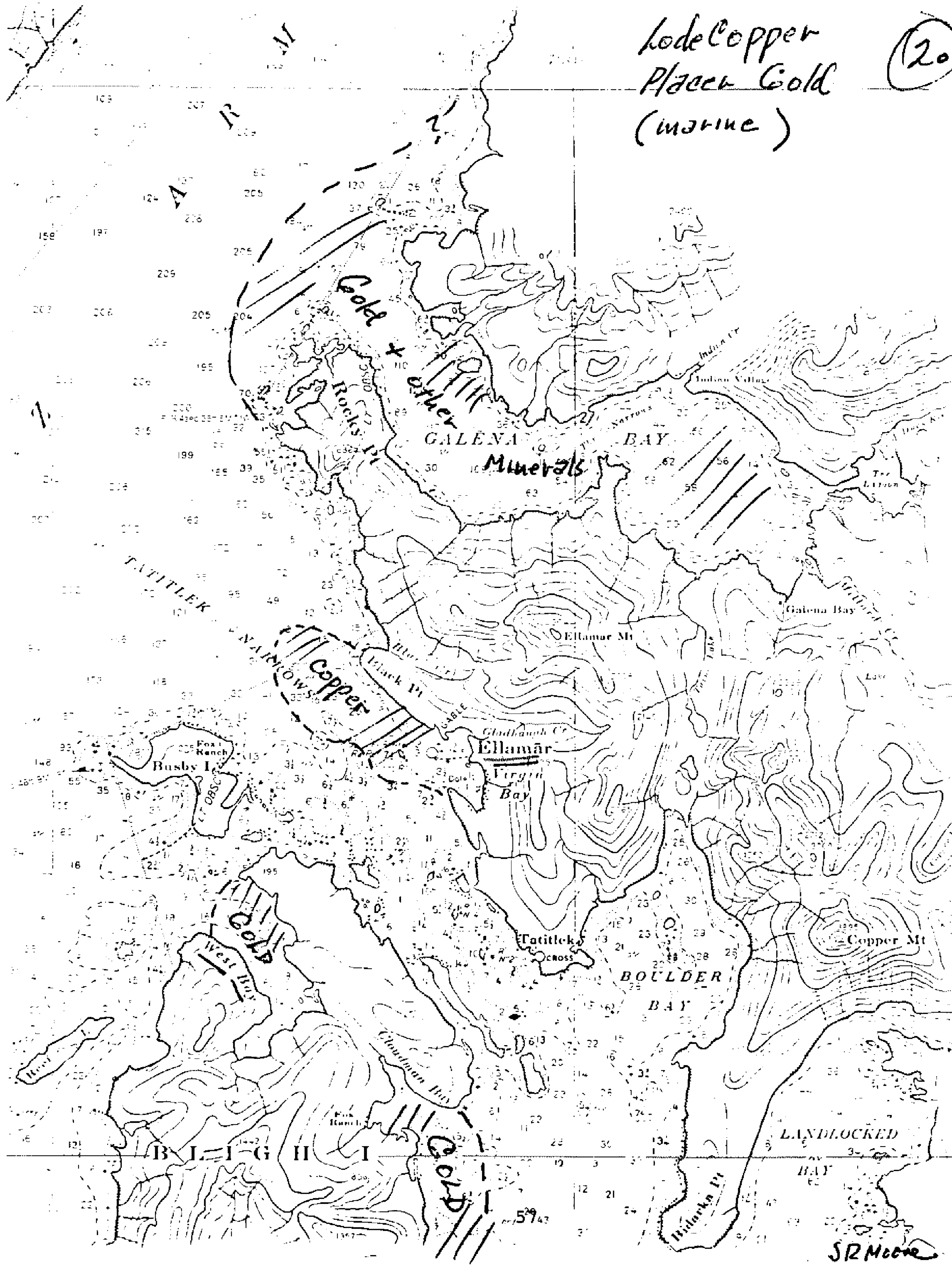
MR. MOORE: Well, based on probable production at beach the "rich" beach line, oh, I'd say a good round number figuring the really good "pay" not the bad, might be 4.5 to 5 cubic yards, something like that, up to 10 or 15 yards per ounce...troy ounce. This would be "hot spot" production only. It would be uneconomic to produce the whole beach zone.



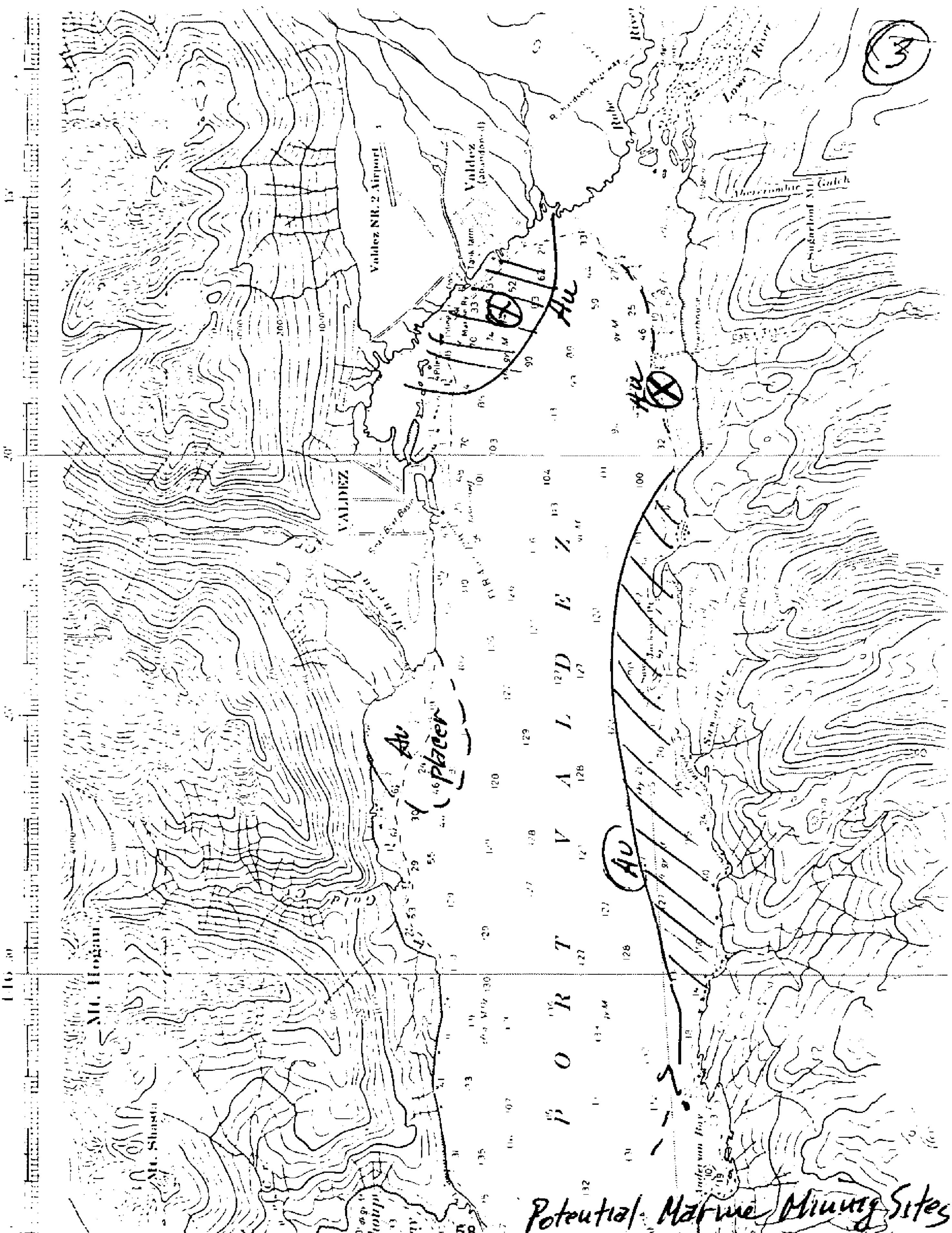
Placer Gold Mines + Prospects

1.

JRMcCRE



Lode Copper
Placer Gold
(marine)
(20
Gold + other
Minerals
GALENA
BAY
Rocks Pt
Copper
TATITLEK
NARROWS
Black Pt
Ellamar
Ellamar Mt
Virgin
Bay
Busby I.
Fox Ranch
Galena Bay
Indian Valley
Indian Cr
The Narrows
Gold
West Bay
Tatitlek
BOULDER
BAY
Copper Mt
Gladhaugh Cr
Gold
BLIGH I
Fox Ranch
LANDLOCKED
BAY
Bidarka Pt
SR Moore



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Potential Marine Mining Sites

JR Moore

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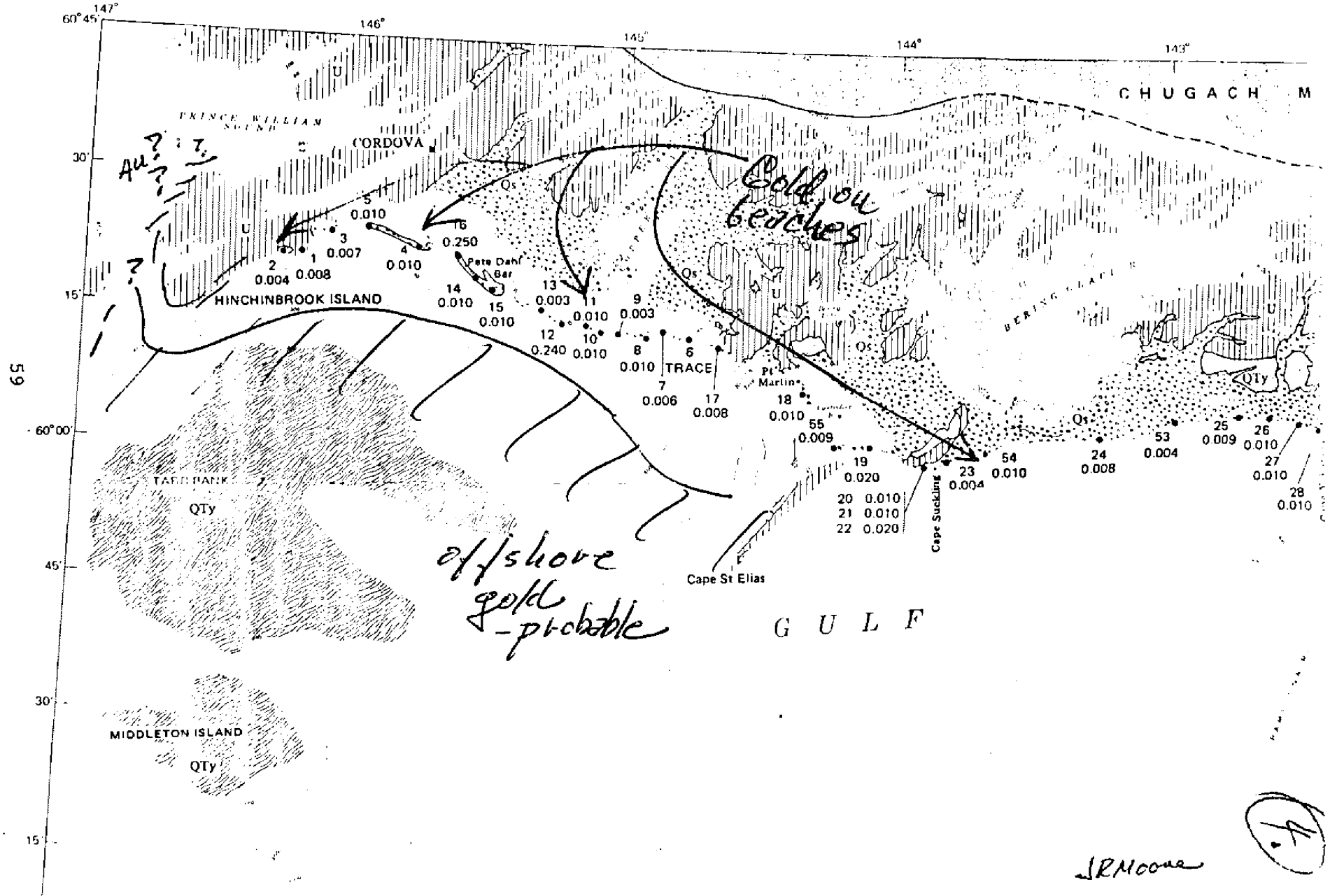
UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY



JRMoore

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SUMMARY OF THE RECREATION RESOURCES

Neil C. Johannsen*
Chief of Planning
Alaska State Park System
Anchorage, Alaska

Highlights of Slide Program

Recreation is an activity, not actually a resource. Whereby most resource management efforts lead to provision of tangible products such as oil and gas, timber and minerals, recreation planning and management activities are oriented towards "human experiences." Prince William Sound, however, should be considered an important "recreation resource."

Recreation should be defined as people's (chosen) constructive use of leisure time.

The most significant (in terms of total user numbers) recreational use of Prince William Sound actually takes place on the decks of the state ferries M/V Bartlett and Tustumena, as well as on the private cruise vessels Glacier Queen and Columbia Queen. The scenic "viewshed" of the Sound along these ships' routes should thus be managed for their scenic/ recreation qualities.

Important recreation "destinations" in Prince William Sound are tied to other modes (than ferries, cruise vessels) of transportation such as pleasure boats, including power, sail and hand-powered kayaks. Wheeled, float and amphibious aircraft are also significant recreational modes of transportation in the Sound. Among destinations where such multi-modal transportation craft focus are: Passage Canal and Port Wells area, including College and Harriman Fiords, Esther and Culross Passages. Eshamy Bay, Columbia Bay, Port Valdez and the Orca Inlet are also heavily visited as are the outer coasts of Montague Island (mostly aircraft) and southern Knight Island and Jackpot Bay.

Whittier is becoming an important recreation "staging" area, with such activities centering here as:

Sailboat charters by Alaska Wilderness Sailing Safaris
Bear Brothers and National Outdoor Leadership School
Kayak trips
Ferry M/V Bartlett (dock)
Columbia Queen and Glacier Queen cruise boats (dock)
Whittier Small Boat Harbor, now about 100 boat slips, but planned for expansion.

*Mr. Johannsen is also co-auther (with his wife Elizabeth) of the book EXPLORING ALASKA'S PRINCE WILLIAM SOUND: ITS FIORDS, ISLANDS, GLACIERS AND WILDLIFE: ALASKA TRAVEL PUBLICATIONS: 1975.

The Alaska State Park System is planning a marine park system in Prince William Sound. Lands for this system are being selected under the auspices of the Alaska Statehood Act. About 25 such marine parks are planned in the Sound, all relatively small in acreage.

Wildlife viewing, particularly for pelagic birds and marine mammals, has become a significant activity in the Sound during the past few years.

In conclusion, we can expect recreational use of the Sound to increase significantly in the future. Native land selections in the Sound will be significant to recreation use since some of these selections will undoubtedly be used for such activities/ developments as lodges, cabin sites, fueling stops, etc. Small boat harbors are receiving hundreds of applications for slips and expansion of harbor facilities will probably result. This means more private recreational craft and their attendant demand for fuel facilities to increase their functional travel range in the Sound. Recreation use in Prince William Sound will increase the demands upon the land managers (primarily the U.S. Forest Service, State and Native Corporations) to maintain the aesthetic, recreation, wildlife and wilderness values now present.

SUMMARY OF THE URBANIZATION

Glenn Akins
Director of Program Coordination
Department of Environmental Conservation
Juneau, Alaska

When Neil Johanssen's friend from Knight Island goes on his next trip to Cordova 25 years from now, what kind of a town is he going to find? I guess that's what I'd like to talk about. The speakers this morning told you about the resources of the Sound and how they're being used. One of the basic questions that we have to ask then is how will those resource uses affect the way the people of Prince William Sound live on the land and how they use the land? Will community development in the Sound increase to the extent that other resources are threatened?

The answer is probably not if we manage properly what happens in the Sound. There are some major questions such as another Northeast Gulf lease sale or perhaps a find based on the current exploratory drilling that's going on. But we really don't have those answers right now.

Prince William Sound was first occupied by the Eyak Indians, who lived in the Copper River Delta and in the vicinity of Cordova and by the Chugach Eskimos who lived on Hinchinbrook Island and in Tatitlek and also in Chenega. A few years ago Neil Johanssen did a Heritage Resource Inventory of the Alaskan coastline. I looked at the work he had done on the Sound and found that there are over 100 archeological sites identified along the shoreline of Prince William Sound. The best known is Palugvik on the south coast of Hawkins Island. Palugvik is the largest and most extensive site excavated to date in the region and it is listed in the National Register of Historic Places.

The distribution of archaeological sites in the Sound demonstrates that the present pattern of settlement along the shoreline is a continuation of a traditional pattern. The sites are located primarily on strategic headlands and along the numerous islands, bays and inlets of the Sound.

A 1977 resource inventory of the Cordova region by Al Meiners of the State Parks Division includes an important recommendation that heritage sites in the Sound area be protected from development activity until such a time as their significance can be adequately assessed.

The report includes the observation that identification of archaeological sites in the region results primarily from field work done in the 1930s and that much field inspection remains to be done. Any work program for inventory or planning in the Sound area should include a detailed identification, protection and investigation of archaeological sites.

The European discovery of Prince William Sound dates back to 1741 when Vitus Bering sent a party ashore on Kayak Island. We seem to make a lot of the discovery of various places. It brings to mind Kurt Vonnegut's observation that 1492 may not necessarily be the date that Columbus discovered America but rather the date the sea pirates arrived.

European activity in the Sound was limited to the establishment of a fur post on Hinchinbrook Island in 1793. Furs were quickly depleted and by the time of the Alaska purchase by the U.S. in 1867 little activity was taking place in the Sound. By the 1890s gold seekers were arriving at many points along the Alaskan coast seeking routes to the interior. The first travelers reached the Valdez townsite in 1897. By 1900 there were 3,000 to 4,000 permanent residents in Valdez serving the thousands of travelers who stopped in the town before heading over the Valdez Glacier to the interior.

Cordova was not quite like that. At the turn of the Century, according to Sheldon Jackson's account, the community had 25 Indians, 25 white men with only a little fishing to support them and 25 stills, which produced 2,500 gallons of liquor. In 1906 the construction of the Copper River and Northwestern Railroad began. In 1908 Cordova was incorporated. The community began to grow as the only other significant community in the area other than Valdez. Whittier was not yet settled and the Villages of Tatitlek, Chenega and Nuchek were the only other settled locations in the Sound.

Nuchek was abandoned in 1930. In 1942 the Whittier townsite was platted as a part of the construction of the Alaska Railroad. The Great Earthquake of 1964 changed the community development pattern considerably. The Earthquake caused tectonic uplift of 6.5 to 7.5 feet in the Cordova area. Sea waves destroyed the waterfront area, Whittier and the old townsite of Valdez. The Village of Chenega was also abandoned.

In 1971 Whittier was incorporated as a result of the decision of the U.S. Government to dispose of land in the area. Most of Prince William Sound, as you've heard from the various presentations, could not be considered urban in any way. Flat or gently sloping land is in very short supply. Although some land will pass into private ownership through municipal and Native land selections, most land will remain in public ownership.

At present there are less than 200 permanent residents of Whittier. Land suitable for urbanization is not readily available in the community. The land use is dominated by the Alaska Railroad and the U.S. Army, which occupy approximately 100 acres and the city which occupies another 100 acres. And there are a few other small tracts in private ownership.

The developed and developable areas of Whittier are limited to three locations along the shoreline. The west camp area at the head of Passage Canal is totally occupied by the east portal of the Alaska Railroad storage tanks and the airstrip. The Whittier Townsite on the south shore of Passage Canal is dominated by the Alaska Railroad properties and by public buildings. And finally the Shotgun Cove area, which has been identified as perhaps future development, is about a mile east of Whittier.

Cordova has approximately 2,000 permanent residents, most of whom depend on the fishing industry. Most of the development in the Cordova area, which occupies about 400 acres, is within the corporate limits of the community. About 70 acres of the land in Cordova is in residential use, about seven acres in commercial use, 88 acres in industrial use, and most of the land, 250 acres or more than half, is in such public uses as the ski area, the airport and the park.

The population of Valdez has increased quite a bit in the past several years. The community area of Valdez is over 274 square miles within the city limits, and the community's existing plan claims that about 60 percent of that is developable land. Besides the giant Alyeska terminal which dominates the shoreline of Port Valdez, other residential and commercial areas are scattered over a very broad area of the city.

The city's planning document in 1971 claimed that less than one-half of one percent of the land area of Valdez was in developed uses and that the community could support a population of up to 15,000 people.

The Village of Tatitlek has been continuously inhabited. It has a population of over 100 and an enrollment of 215 under the Native Claims Settlement Act. Although Chenega was abandoned in 1964, apparently there might be some interest in eventual resettlement of the area.

What would bring about any significant increases or changes in the urban land use in Prince William Sound? You've heard quite a bit about resource development, but there doesn't seem to be any very definite projections available. In the near future municipal and Native land selections will bring more land into private ownership in the areas around Chenega, Tatitlek and Cordova. Expansion in the Valdez area is possible within the

present corporate limits. But without some kind of major economic activity one would not expect any population increases that would result in a dramatic threat to renewable resources.

Slow increases in fishery related industries may result in the implementation of the 200 mile limit bill. Valdez and Whittier are both ports with links to the interior. If in the future there continue to be problems with siltation in Cook Inlet, there could be interest in greater general port expansion for other than just oil shipping. Both Valdez and Whittier are in competition with Seward, which is linked to Anchorage by both boat and by rail year-round.

Some increases in Cordova and Valdez are occurring now as a result of monitoring of the tanker lanes. As land passes into private ownership there might be some increase in the forestry industry, but it doesn't look like that would result in a dramatic increase in population.

The biggest question is probably related to offshore oil development. Currently there remains one exploration rig working in the Northeast Gulf. A lot of the concern about the Sound being a service and supply base has so far not been founded. The exploration in the Gulf has been serviced primarily out of Seward and out of Yakutat. Even though an additional sale may be held in August of 1980, unless there is a dramatic change from what we've seen recently, there probably will not be a major impact in the Sound.

In Whittier, as Neil pointed out, there will be continued increases due to recreational development. One of the major questions that we would have to look at is the impact of municipal and industrial waste disposal of the Sound.

At present Whittier has no domestic waste treatment plant, but the community is working with the Department of Environmental Conservation on planning for the construction of a system. Cordova has a 700,000 gallon activated sludge treatment plant, which was completed in 1976. The Department of Environmental Conservation claims that at present the Cordova system is overloaded primarily because of storm drains coming into the system. There are about 500 hookups and when the system is not overloaded it meets DEC effluent standards.

Fish processing wastes in Cordova are disposed of by ocean outfall independent of the sewage system. Valdez has a 1.25 million gallon a day aerated lagoon system which discharges to a percolation lagoon. Corrections are currently being made to this system to provide chlorination, but the effluent in Valdez currently meets state standards. The Village of Tatitlek currently disposes of domestic waste through a 12,000 gallon septic tank on an ocean outfall.

What then are the big conflicts? There's the possibility of continued development in the Valdez area as a result of the Alyeska terminal. There is the off chance of either a find under the current Gulf sale or perhaps greater activity resulting from the next sale, a small amount of recreational development in the Whittier area. Basically when we look at the possibilities, I think we can see that it can be adequately managed if there is a proper amount of consideration of these conflicts during the planning stage. I think that in the design of any kind of project inventory by the MESA Program, the possible uses of the information developed on the comprehensive plans of the committies on the Sound, should definitely be looked at.

SUMMARY OF THE TRANSPORTATION

Chris Low
Transportation Planner
Department of Transportation
Juneau, Alaska

The issue in the Sound as far as transportation is concerned isn't marine transportation. Basically what it is is access to the outside world, as the area is painfully aware.

I'd like to combine a discussion of access with a few words on some of the technologies that have essentially defined the transportation that exists now on the Sound and then perhaps comment on the general transportation planning process that we have been looking at for the past year or so and some of the holes that we found.

The two areas that are most concerned with access are Cordova and Whittier. With respect to both of them the question is, what kind of improved land access can be constructed? With respect to Cordova it was the possibility of constructing the Copper River Highway and, indeed, the way that that project was undertaken, which led to my study, which is basically the result of a suit filed against the state by several conservation groups.

The question of access and the way we have looked at it, specifically with respect to road access, is to ask ourselves what would happen if we put a road in to both Whittier and Cordova. The way we've analyzed this is to say we can estimate traffic that we would have, for example, on the Copper River Highway by looking at the traffic that was generated in Valdez when Valdez had a similar population.

We start with about 110 cars and get up to 300 cars in a period of 20 years. This again is assuming, as previous speakers have mentioned, that you're not going to suddenly have the El Paso line come back and a major economic development there; although, sustained growth of about five percent would probably occur.

The Whittier situation is significantly different, because if you put 10.5 miles of road in there, suddenly you've got another suburb of Anchorage. We're looking at roughly 900 to 950 cars average daily traffic. Given the rate of growth in the Anchorage area that may be an underestimate.

What it all boils down to is that we're looking at a question of resource allocations, specifically we're looking at very significant sums of money to build both of these roads. We've

estimated in excess of $100 million for the Copper River Highway and roughly $15 to $20 million for the Whittier Road if it can be built. There is a significant question in engineering circles as to whether or not it can be built. I spent three days in Whittier last week. We gave our presentation on Wednesday and spent Thursday and Friday discussing with all of the 64 families that were in town why it is we came up with somewhat the wrong conclusion. Very charming people, and everyone of them knows that they want to get out more frequently than they do.

At any rate, the thought I would like to leave with you in our rather abbreviated tour of Prince William Sound access is that the decision on something like this cannot be made except in the state context. You're looking at a level of investment for either Whittier or Cordova that would very significantly affect the total amount of money for all highways in the state. The decision, therefore, has to be made in the context of what it's going to take away from.

I know you can argue, and I have argued at some length, that when we look at most of the other roads built in the state if you'd gone in with a slide rule and decided where the costs of the benefits were, you probably never would have built them. On the other hand, how do you explain that to someone whose road has been either not maintained or not improved because of a very significant concentration of resources in this one area.

I'd like to touch a little bit on some of the technologies that make the Sound transportation system and its usage what it is today. The only community in the Sound that is actually serving as a gateway for inbound freight to any extent these days is Whittier. The reason they can do that is because they have a rail dock. By completely ignoring the need for longshore labor, they can have roughly 90 rail cars delivered from either Seattle or Prince Rupert for the cost of a tug and a five man crew. These rail cars are then pulled off directly by the train, no intermediate labor whatsoever is involved. The rail cars can be pulled to either Anchorage or Fairbanks.

This has shown itself to be the most economical way of getting freight from the Lower 48 to the Anchorage area. The cost comes in when you get to unloading freight cars, which is why the operations of Sea-Land and Tote going directly into Anchorage have continued to grow.

The other major community that would like to have major inbound freight activity is Valdez. Of course, Cordova would, too, I assume, if there was a road. Valdez has been very anxious to get freight movement between the Lower 48 and Fairbanks. As I will be suggesting to the Valdez planning council tomorrow evening, this faces a very challenging situation because once

you get the trucks from Valdez to Fairbanks, they are very likely to go to Anchorage. There is then one leg of the triangle that would be a challenge to maintain; in other words, there needs to be some economic incentive for the truck to get from Anchorage to Valdez, which from our investigations cannot be entirely justified.

I mentioned that as we have looked at the Sound area and particularly its transportation problems, we came upon a few flaws, or what we look at as flaws, in our own planning process and the way we think about transportation. Particularly for Alaskan applications traditional transportation planning generally depends upon traffic. No where in the state do we have the amount of road traffic or frequently the amount of marine traffic that justifies the investments we have to make to maintain and particularly to build new transportation facilities.

To the extent possible, if the state could develop policies to give guidelines to the planning fraternity attempting to use the tools developed elsewhere for making policy recommendations on Alaskan transportation questions, we'd get a better product. Right now we can certainly say that with respect to access to Prince William Sound and, indeed, with respect to statewide transportation facility evaluation, we're so far on the bottom end of the curve on most of it that we lose our basis for comparison.

I haven't said an awful lot about marine transportation, but it seemed to me from our discussions with the citizens recently that the issues uppermost in their minds were more those that I have talked about. I know there'll be a lot more discussion in the workshops. If there are any questions I'll be happy to answer them.

UNIDENTIFIED: What's your perspective of mass transit and railroad as an alternative to highways?

MR. LOW: With respect to Whittier and the railroad, I should mention as a preface that the state is sort of going backwards as far as its support of the railroad into Whittier. We used to subsidize it and now that has stopped. We used to give them roughly $250,000 a year to maintain a shuttle between Portage and the ferry in the summer. There is no service to Whittier by the ferry in the winter. The railroad is currently serving the town three times a week.

From the standpoint of priorities, particularly in the summer, the local population is sort of at the bottom of the totem pole. If you've got a ticket to the ferry you get on the train and if not you wait until there's a place. From

the standpoint of economy the railroad, given the current situation, is miles ahead.

The big challenge, of course, is that the people I've talked to in Whittier like to consider themselves similar to a suburban situation. They'd like to be able to get to Anchorage easily. That means you cannot have what we call a bud car, which is a self-propelled rail car that would take you from Portage to Whittier and back because the Whittierites like to take their cars. This means you've got to go with a whole engine and a set of flatcars to get the automobiles there.

Our recommendation to improve the situation that currently exists for Whittier, is that they look into getting a used self-propelled car. This would run about $200,000. If they could work out a situation where the city was operating it rather than the state or the railroad, they could get by with two people. The state law is that you have to have a full crew on any train operated, which means you've got to have five people. The railroad has umpteen more regulations as far as their labor contract goes.

In answer to your question, the railroad's far cheaper. It's a question of what the individuals who are going to be using the service are willing to accept. Right now, I'd say, according to the material I have, the orientation is to push for the road as much as you can.

Thank you.

CONCLUSION

Raymond S. Hadley

It's now time to get down to the meat of the conference; setting up the workshops, getting to work, and hopefully producing an end product that will be helpful in securing a project under MESA's direction in Prince William Sound.

On your agenda you'll note that there were five projected workshops. We're going to have to make a change in that. Due to previous commitments of everyone we contacted, we will not be able to set up a transportation workshop. We could not find a leader who was able to stay for the duration of the conference. Because of that may I suggest that those people who were interested in this facet attempt to blend into the other workshops. I don't think very much will be lost by this since the document which we hope to create Thursday morning is intended to be a synthesis from all the workshops.

We now have four workshops, renewable resources, non-renewable resources, recreation and urbanization. Rick Rosenthal will be leading the renewable resources workshop. It will be meeting in the Alaska Room. Robby Moore will be heading up the non-renewable resources workshop, which will be in the Aleutian Room. Neil Johanssen and Al Meiner who work together will be heading up the recreation workshop which will be in the Kenai Room. Al may have to head this workshop alone if Neil's case of flu gets any worse.

Someone you haven't met as yet, Marsha Erwin Bennett, who is currently teaching a course at the University of Alaska, Anchorage campus, in urbanization and has taken part in an urban study in Port Valdez, is kind enough to head up the urbanization or community development workshop. This group will meet in the Commodore Room.

We have gotten together with the chairmen of these workshops and have given them what we call the roadmap, some ideas that we want them to pursue. These are very open. We hope that in a completely free way you will split up relatively evenly according to your particular interest or expertise and background. I'd like to see as much intermixing as possible so that our final outcome represents the whole community and all the parties interested in it.

We will be meeting on Thursday morning for the workshop presentations. During that time we all hope for a good deal of interplay between workshop participants. As I mentioned this

morning we think it's good to cross workshops, but we hope you'll stay with the one you start with long enough to give realistic input and help us get something out of it.

The first thing we'd like you to do once you convene your workshop is to give us a list of the names of the initial participants. From that we will be able to judge the balance we have achieved. If absolutely necessary, we will probably twist a few arms and ask people to participate in another workshop.

There is going to be a MESA participant in every workshop. I suspect they might switch from workshop to workshop. I guess I can wish you all good luck, and I think we shoud split up right now.

INTRODUCTION TO WORKSHOP RESULTS PRESENTATIONS

Raymond S. Hadley

This morning's session is a wrap-up of what has occurred in the four workshops held. We request and seek your comments as we proceed, limited only to the scope of the general workshop and the time allowed. If you do have comments I ask that once you are recognized you come up to the front microphone stand so that our recorder can pick up all your comments. Tell us who you are, where you're from and make your commentary or ask your question.

I hope all of you here today have registered. In order to receive a copy of the proceedings we will need your registration card, so if you have not as yet registered, please do so.

We were unable to have a transportation workshop, as you all know. We have tried to fit most of that information into the other workshops, but I was informed this morning that some of the people from Whittier would like a chance to comment on Chris Low's opening statements that were made two days ago. I think because of the lack of a transportation workshop we will definitely give them that audience.

Following the presentations we will have a summation from Chris Carty and, hopefully, come to the end of what I think has been a very good conference all along. I think the MESA people are happy with it, I'm certainly happy with it, and judging by the participation and the activity that occurred in the workshops proper I think most, if not all, the participants are happy.

URBANIZATION WORKSHOP RESULTS PRESENTATION

Marsha Erwin Bennett
Consulting Sociologist
Anchorage, Alaska

We had the task of looking at the humans in this ecosystem, at looking at the communities on this complex estuary, and trying to identify some of the issues that relate to the human inhabitants of Prince William Sound. We spent a good bit of time discussing issues relating to Cordova, Valdez and Whittier. We didn't have any input from the small Native villages in Prince William Sound, unfortunately, so most of my comments will be with reference to the three communities that had representatives at the workshop.

If you think of Alaskan communities and Alaskan humans in relationship to the natural environment, I think there is a difference. People in Alaska are closer to their environment, and because they're closer to it and interact with it in a more complete way, the balance they seek and obtain from that natural environment speaks to their spirit, speaks to their ability to be whole human beings. And I think that's really what we're talking about when we're talking about a marine environment that is a wilderness environment. We're also talking about the humans who inhabit that environment and their relationship to the water and to the land that surrounds it. It's a relatively balanced interaction, relative to the rest of the MESA project estuaries, that is.

One of the things that's implicit in what I just said is that people who live on the Sound want to be involved in the research that is undertaken here. They want to be informed of the results. They want to participate in the information flow that comes out of this study. And that was definitely something that we heard loud and clear in our workshop. Hopefully, that can be part of the process that is the MESA study program.

Prince William Sound is one of the largest most complex estuary systems in the world, unique in its wilderness complexity and beauty. It also has a long history of human habitation, first by the Chugach Eskimo and Eyak people, who have long resided here and later by White settlers who came to fish or mine along its shores.

For the most part the people who have resided here have lived in harmony with the Sound and with the land surrounding it. They have grown to love the water and its plant and animal life, gain sustenance from its lushness, renew their souls in

its quiet waters. This harmonious relationship with the Sound has a long history. The people here are probably different from those found on most urbanized estuaries. They are tied to the water through fishing and boating, through subsistence activities, through a long tradition of responding to and interacting with the land and the water surrounding them.

Each community along the Sound has a sense of independence, a sense of its own identity, a purpose around which its residents can agree. Yet each resident and each community has a strong tie to the Sound, a sense of protectiveness about Prince William Sound. Most are willing and eager to learn ways of protecting it from imbalance, curious to learn of the complex interactions they, too, sense. Their life in Prince William Sound leads them to expect genuine interaction from scientists interested in studying the Sound. They want to be informed of research going on here. They need to participate in the forming of research questions and then integrating the findings into the ongoing life of the communities in which they live. Community feedback should be part of this MESA project undertaken in Prince William Sound.

The Urbanization Workshop was concerned with a number of issues relating to patterns of human settlement on the Sound, community interactions and future plans within the Sound. The testimony we have received we have organized into three categories. First, patterns of existing settlements will be discussed. The communities of Valdez, Whittier and Cordova all have representatives who contributed a great deal of information about their communities, their concerns and future plans. Less information is available for the villages of Tatitlek, Eyak and Chenega.

Second, we discussed intercommunity relationships along the Sound which may affect Prince William Sound estuary. Finally, we discussed future development in the Sound, both planned and anticipated.

Whittier

The Town of Whittier had a 1970 population of 130 full-time residents. It's a small community tied to Anchorage by its small boat harbor facilities and its railroad access. Its economy is dependent upon recreational boating activity largely emanating out of Anchorage, ferry traffic between Anchorage and Valdez and limited commercial shipping.

The small boat harbor now consists of 125 boat slips with plans for addition of another 100 in 1978. Future plans call for 1,000 to 1,200 boat slips in the Shotgun Cove area. Whittier also has a small herring processing

plant, which may pose some water pollution problems. Whittier is a second class city in an unorganized borough. Its sewage treatment facility has the capacity for handling 3,000 population by 1990. An incinerator has been purchased for disposing of solid wastes. A holding tank is planned for boat harbor use. Future development depends upon expansion of the demand for boating activity from Anchorage as well as probable development of an 11 mile road, which would connect Whittier and Anchorage. State and Native land conveyances, too, will probably accelerate development at Whittier.

The Whittier area experiences extreme wind conditions resulting in unusual circulation patterns and tidal conditions. Waste disposal for Whittier would require a better understanding of such properties. Proposed expansion of the small boating activity should be planned to include adequate provision for small boat wastes. The winds leading into Whittier pose some problems in terms of the dispersion of sewage from the Whittier shoreline.

Valdez

Valdez now has a population of roughly 5,000. In 1974 to 1976 the boom population of Valdez was approximately 7,500, at least one-half of which was involved in the construction of the terminal facility for the Trans Alaska Pipeline Project. The former 1970 population of Valdez was 1,005. We have a tremendous increase over a very short period of time.

In addition to the terminal facility, Coast Guard and other monitoring activities associated with pipeline and tanker activities, Valdez also has several state government facilities, a modest tourist trade and a small fishing fleet, commercial dock and ferry terminal and a small boat harbor for recreational fishing. Valdez is a first class city in an unorganized borough. Sewage treatment capacity is good with the new aerated lagoon system.

Valdez is a wealthy city due to oil generated revenues with continued interest in future industrial development. Recent interest has centered on petrochemical development, expansion of tourism and fishing industries and dock activity. On the other hand, realistic plans for Valdez probably will involve a period of readaptation from its rapid population growth induced by Pipeline construction to a smaller stable community size consistent with levels of current economic activity there.

Valdez is connected to Anchorage and Fairbanks by road, to Cordova and Whittier by ferry, and is served by two small airline companies as well as by Alaska Airlines on a charter basis. Its new airport terminal facility is serviced by FAA at this time.

Potential oil spill damage to Prince William Sound has been the subject of considerable study and concern over a period of many years. Oil spill containment and contingency planning are vital to an adequate response should an oil spill occur.

Cordova

Cordova is a working community of commercial fishermen, both by economic necessity and community history. Faced with the declining fishery of recent decades, the major economic thrust of the community has been stock enhancement through fish hatchery development or aquaculture. Cordova is an isolated community of 2,406 residents (1976) enclosed by Native, Forest Service and State land selections. It is seeking to broaden its economic base and to reduce its extensive isolation from supply centers, to encourage development as a state correctional facility, to reduce its seasonal employment pattern and to encourage harbor and road access to the community. Sewage treatment capacity is adequate but water supply and electrical capacity are present problems.

Cordova is a second class city in an unorganized borough. Its taxes are high and economy is highly seasonal at this time. Residents look to compatible development consistent with its fisheries based past and expect growth from the passage of 200 mile limit regulations.

Bottomfish processing facilities might add an additional 2,000 population to Cordova. At present there are 340 boat slips in the small boat harbor with another 200 planned. Virtually all boats are commercial fishing boats. An additional 250 fishing vessels from the Seattle area locate in Cordova during fishing season.

Cordova has half hour air access to Anchorage and is connected by air to Southeast Alaska communities, Seattle and points south by Alaska Airline's flights.

Plans along the line of aquaculture and fish hatchery development bring with them certain impacts on the Prince William Sound ecosystem. The most significant of these relates to the effects of the fishery enhancement program. Rapid expansion of fish hatchery activity without regard to the effect on other species in the food chain might disrupt the system balance. As with any ocean going or fishing operation, better understanding of weather patterns, tides and currents is of basic importance.

Tatitlek

Tatitlek is a small village of about 200 people close to Valdez. Its economy is largely subsistence based fishing and hunting. Since MESA input from the community has been minimal, more information needs to be collected concerning this community.

Chenega

Chenega is a village which had a 1974 Native village enrollment of 68 people, although it has not been a viable community for some time. Plans for this community, however, include resettlement by former residents and perhaps relocation to a more economically viable location on Evans Island. Here, too, more information is needed since no input from local residents has been obtained.

Eyak

Eyak is a village of about 321 residents, according to the 1974 Native village enrollment figures. This village shares land with the City of Cordova. Native land conveyances are anticipated in 1978, which could affect development plans in both this village and Cordova. More information about this village is needed.

Future Settlement

The consensus of the workshop supports the view that recreation and fishing activity will be the predominant economic activities in Prince William Sound for the foreseeable future. Mining activity on several islands might become feasible given market conditions. Industrial development in Valdez or Cordova and rapid tourist expansion in Whittier could occur, but are less likely predictions. Lumbering activity is anticipated to remain small and localized, primarily in the Whittier area.

We also spent a bit of time, both informally and within the context of discussions of individual communities, talking about the interactions between communities that take place in Prince William Sound. I think perhaps one of the potential benefits of the MESA project would be the sense of a whole that you can give back to the communities, a sense of their interrelatedness around the Sound.

In spite of the strong independent stances of the traditional communities located along Prince William Sound, there is a growing awareness of their interconnectedness. Our workshop discussed the potential for area-wide borough government and

planning. Recognition of the Sound as an interconnected ecosystem leads naturally into a regional approach to planning and development. Especially now that Valdez has weathered its Pipeline impact and is looking more to development of tourism and fishing capability, the sense of unity of these villages and communities along the Sound certainly has potential for encouragement. Thank you.

MR. HADLEY: Are there any questions? Comments? Pete.

MR. ISLEIB: Just a correction. Cordova's a first class city.

MS. BENNETT: First. Oh, sorry.

UNIDENTIFIED: Another correction. It's a home rule city.

MS. BENNETT: All right.

MR. BLAKE: Another question. Do we get another crack at this paper before this becomes the final document that's submitted? I came in when the presentation was half over, but I heard half a dozen minor discrepancies in there that I think should be corrected. I'd like to get a chance to attack it on paper before it's turned into a final document.

MS. BENNET: Feel free.

MR. HADLEY: Yes, Bob, we can send you a copy of it before we produce the final proceedings and be happy to accept the responses. We'll send it directly to you, too. If there are no further questions on Ms. Bennett's presentation, maybe this is the appropriate time for one of the Whittier residents to make a short presentation concerning the opening summary statement on transportation. Virginia.

MS. BENDER: I wish to challenge Mr. Low's figures on the cost of a highway into the City of Whittier. I would have done so in the workshop if it had come about. There has never been a nuts and bolts engineering cost of a highway into Whittier. The State Highway Department is pulling figures out of thin air. The City of Whittier did last fall request a study, a feasibility study, and we were told by the State Highway Department there were not funds available. I want to plant in all of your minds that there are no figures available of a cost into the City of Whittier by the State Highway Department.

In 1967 a contractor offered to build a four-lane all weather road and pipeline around that

mountain for the figure of $6.2 million. Peter Kiewit and Sons offered to build a pipeline and a tunnel for $7.2 million. Mr. Joiner, was there a road connected with that project?

MR. JOINER: No, just a pipeline and tunnel, including the pipe for the tunnel; no road.

MS. BENDER: These are 1967 figures, but plant in your mind, it was a four-lane all year road. We're not asking for that; we're not asking for a four-lane all year road. Thank you very much. I wish you'd keep those figures in mind.

URBANIZATION WORKSHOP SUMMARY

OUTLINE OF WORKSHOP HIGHLIGHTS

I Patterns of Existing Settlement
Valdez--Whittier--Cordova--Tatitlek--Eyak--Chenega

- A. Population
- B. Economy
- C. Future development prospects
- D. Obstacles to future development
- E. Other factors
- F. Environmental baseline
- G. Transport and other interactions with other Prince William Sound communities
- H. Impacts on Prince William Sound marine environment
- I. Conflicts affective or potentially affective on Prince William Sound marine environment

II Inter-Community Interactions Which Affect Prince William Sound Ecosystem

- A. Inter-community economic relationships
- B. Patterns of transportation
- C. Tourism and recreational interrelationships
- D. Communication ties
- E. Governmental interrelationships
- F. Other social interactions
- G. Non-consumptive natural resources
- H. Heritage in Prince William Sound

III Future Human Settlement Scenarios

- A. Growth in existing major communities

B. Native village growth

C. Future recreational site development

D. Future mineral development in Prince William Sound (Bligh Island--Islands around Chenega)

E. Effect of future settlement patterns on marine ecosystem

- Recreational pollution
- Fishing boat pollution
- Industrial waste
- Litter
- Municipal sewage

F. Future energy sources

PARTICIPANTS IN URBANIZATION WORKSHOP

NAMES	AFFILIATION
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Mike Schmidt	University of Alaska
Tom Lonner	Peet, Marwick, Mitchell & Co.
Michael L. Crane	EDS
Perry Lovett	Cordova City Manager
Doris Bender	Council Person, Whittier
LCDR Michael Macie	Coast Guard
Priscilla Post-Wohl	Dames & Moore
Chris Hansen	Valdez
Chris Carty	MESA/NOAA
Clay Beal	U.S. Forest Service
Philip Munger	Harbormaster, Whittier
M. Pat Wennekens	University of Alaska
James L. Wise	University of Alaska
Marc Petts	U.S. Forest Service

NON-RENEWABLE RESOURCES WORKSHOP RESULTS PRESENTATION

J. Robert Moore

The program element for non-renewable resources was considered by probably the smallest board group. And I would say, Mr. Chairman, that we found it regrettable that we had no direct industry input into the program.

In reviewing this, the non-renewable resource group has determined, with some outside input, that we cannot be concerned with oil production within the confines of Prince William Sound as defined for this workshop, so oil and gas are out.

Of three types we spoke to yesterday; lode, placers and sand and gravel, it may turn out that sand and gravel will have a bit more impact than we originally thought, particularly in the Cordova and perhaps in the Valdez area.

As best we can determine at this time, there is some sand and gravel extraction activity in the Cordova area, gravel being produced on the forest lands; some geochemical and field geological parties, a few (two to four at most) working in the uplands area and a few in the Hinchinbrook coastal zone, but doing largely reconnaisance work. These are parties from either small joint-ventures or typical reconnaisance groups from minerals divisions of major corporations.

From about the mid-1960s to 1973, early 1974, there were some grab sampling and geochemical survey studies made offshore by industrial groups. These were within their own permits held at that time, some of which are still valid, in the Prince William Sound area.

The main point in considering this in this very brief recap is that minerals and mining, of all the human activities, are the least developed so far. My companions here have spoken to or will speak to considerable activity in fisheries and urban development in certain areas and tremendous growth of the recreational activities, particularly at Whittier and elsewhere, but minerals and mining at this point is the least developed, and thus the environmental measurements that we may be able to make in the very near future could be the most meaningful in terms of getting that first thumb on the long road assessment for activities that we project. Heavy activity efforts, particularly in exploration, will most likely occur in the mid-1980s.

In reviewing the significant marine concerns and problems we do see, assuming the right political and economic atmosphere, some considerable activity by the mid-1990s. Some estimates

on this, about 600 workers which would provide something like 1,800 to 2,000 new people in the greater area. For the most part largely near the shore or working out of communities there.

Of interest now, we see the build-up of two small company oriented or resource activity oriented villages. Not quite the old line company town, but something of that size, in the Prince William Sound area. Again, probably right on the shore. An input, if we estimate this in projected dollars, of something like $25 to $40 million a year, including both the payroll and the purchase of goods and services, charter flights, commodities and the like, in the Prince William Sound area. That's additional business coming into the area.

We didn't address it, but there would be some management supervision, logistical offices and activities in the Anchorage area.

The periods of activity, considering the problem of early amortization, high cost of risk capital and external economic factors, would probable be about 20 to 25 years. We do not see a long history of minerals development in the area. Fairly rich, but fairly short.

The key pollution and habitat changes are principally as they relate to the marine environment; disposal of lode mine tailings, the lode mine being that type of hard rock that must be crushed to win the ore. Probably disposal of tailings into waters. There is research underway in several areas of the U.S. and abroad to see how this can best be done, though landfill disposal is a possibility. This would be in cooperative studies somewhere down the line with the U.S. Forestry Service. Land disposal would probably only be at those sites that would be either far removed from the water or in such geographic situations that it would be inordinately expensive to construct the disposal system. Marine placer mining is essentially a sorting of the materials in place. You don't break them up; you don't add anything to them. They're simply sorted and winnowed in trommels and large floating devices to take out that very small, much less than one percent, of the noble metal that may be present.

There may be other possibilities for placer metals than the noble metals. At this time that looks like the best. Probably the disposal of in close tailings would be done on the sea floor. I would caution you in your thinking, the type of Yuba dredge that so many of you see in the Alaska historical photographs and the like would not be used in a circumstance like this. It would be hydraulic mining, airlift methods, off the bottom, brought up through a riser into a processing vessel or barge of some sort and then delivered back to the sea floor again. There'd be no plume on the surface and only a very modest plume around the disposal on the bottom.

In looking a bit further, one specific problem with tailings from the lode would be the 200 to 300 mesh fine tailings disposal, some would be smaller than 15, 20 microns. To look at this in something that you're all familiar with, it would be like the milky water that comes from glacial streams around here, the so-called "rock flour". As a matter of fact, there's a lot more "rock flour" delivered in the system than you'd ever get from this type of operation. However, it's similar to glacial streams and, again, it would have to be considered. Whether there's some flocculating basin or a capture basin, some intermediate mechanism, is hard to say. It'd be a design problem to be worked out with environmental concerns.

One thing of import is that it does show a need for dispersal charts or current measurement charts. There's no way that you can mine the bottom without disturbing the substrate. It will promote a change from some areas where a high mobile sand is common to a highly dispersed sand to a mixture of sand, mud and gravel.

What this means in biological terms would have to be determined by the biological components in such a research program. In looking at the hydraulic systems probably used in the marine mining phase at the mine sites, they would unquestionably capture some few fish and anything else that got right in the suction unit. Depending on the type of bottom, they may introduce some hydrotroilite. This is an unstable iron sulfide or series of minerals of iron sulfide type. A very small amount of that might be introduced. We'd have to look at the bottom in these areas to see if, indeed, it were present, the important point being that this is a highly unstable mineral and would locally cause some small degradation but it rapidly oxidizes into the surficial sediments.

In considering this as a whole, no placer mining will be done where there is only a thin veneer of sediment. No placer mining will be done where it's rock, and no placer mining is economical in waters over about 100 or 120 feet. That restricts a lot of Prince William Sound from ever having any mineral resource activity in it at all. It's simply a matter of economics.

In looking at conflicts, we see two. It may be that others in the group see them and we're certainly happy to hear about them. There are conflicts with the fisheries in water depths less than about 100 feet. It could well be that we may find that one of the hot anomalies for mining is in the pathway of salmon transport and in the season of the movement of these we may have to consider placing the machines on a beach or moving them into town for the crew to have a couple of weeks or a month off.

There is a flexible concern here in that the fisheries follow a time sequence. A mineral resource will sit there from now on to be mined for the most part winter or summer; though, in terms of security for vessels the summer, of course, is the best.

Now, a second conflict; the rare possibility of navigational conflict. I looked at Coast Guard plans for the pathway from the outer Gulf of Alaska into Prince William Sound on into Valdez. Trajecting the geology known at this time, one doesn't see any areas that would hold prospects. Certainly much of it's too deep to operate in, and the regional geology in some shallow areas is not particularly interesting. Nonetheless, it could be a conflict; you could have a barge that got loose; these things can happen.

In recommending investigations, we see one of the most important as studying the current patterns in the vicinity of the most likely mining sites. We think we can make some projections on this, but there might have to be a modest bit of field work to confirm the current patterns in and around these projected mining sites, including some special sites in the inlet/fiord environments. The second would be an investigation of the sedimentological and substrate geochemical interrelationships in potential marine mining sites. This is essentially a process or processes oriented study. It would, as you suspect, begin to relate to some of the biological studies.

Third, some background baseline measurement on copper and other transition metals. Many times these can be used as pathway metals in the substrate. We feel here that there should be a dovetailing particularly in the logistical ship-board operations of certain biological studies and the sedi-mentological mineral studies. It would be using some of the same studies, or could fruitfully use some of the same samples without additional ship time.

Fourth, some special investigations in water around Knight Island, in the Tatitlek Narrows and in two or three of the fiords that we have identified as being of some considerable interest.

The only human conflict that we see of real proximity would be rebirth of the Ellamar offshore with Tatitlek Village some four miles away.

I might conclude by saying that unlike all the other activities presented in this workshop, transportation, a growing pipeline interest, more ships, more activities in terms of sailing and fun time, commerce development, fisheries, underutilized species, mining and minerals recovery in Price William Sound, particularly in the water area and in some of the coastal sites, is only going to be done once. Once the recovery is made of the real estate underwater, you can make a clam bed out of it or whatever; there's no problem.

NON-RENEWABLE RESOURCES WORKSHOP SUMMARY

PRESENT LEVEL OF DEVELOPMENT

Within the Prince William Sound and immediate uplands there is no oil or natural gas production, nor is such production likely to be discovered. The reason for this is that the country-rock on land, and as projected beneath the Sound, is largely composed of very dense, metamorphosed, crystalline rocks in the lower (or older) geologic section, with some marine and terrestrial clastics in the uppermost geologic section. Without a suitable source-rock, and without suitable reservoir rock, there is no promise of oil or material gas production. On the other hand, the several metamorphic, crystalline rock units exposed in the uplands do contain zones of economic-grade mineralization. Some placer mining, modest at the present time, has been conducted in the uplands for three quarters of a century. The now-abandoned copper mine at Ellamar is, of course, an exception. This mine was a major U.S. copper producer from the turn of this century until the Great Depression. Much copper ore remains at Ellamar, in-cluding a large ore reserve extending seaward beneath the seafloor of Prince William Sound (Tatitlek Narrows). Likewise, major copper deposits are thought, by some geologists, to have ore extensions beneath Prince William Sound. In regard to the seafloor mineral deposits, this has been only partially established by grab sampling, high resolution acoustic profiling and geochemical analysis for a few small areas in Prince William Sound. Although of limited production, sand and gravel is produced at Cordova and some gravel extraction has been permitted on U.S. forest lands.

SIGNIFICANT MARINE CONCERNS AND PROBLEMS

Considering the rapid depletion of mineral resources in the Lower 48 States and the unstable economic and political situations that may restrict foreign sources of necessary minerals, and considering a growing exploration activity in Alaska, we can reasonably expect mining in the Prince William Sound area by the mid-1980s. Such mining, while difficult to predict in total reserves, can be projected from the geochemical data available and from review of the prospects and small mining sites already known for the area.

Our panel suggests that by mid-1990s, there will be approximately 600 mining employees actually at work both on land and on water in the greater Prince William Sound area. Considering the service-associated personnel and the family members, we predict some 2,000 "new" people in the area. Further, this population will likely be clustered in two small company camps-villages (Knight Island and Ellamar areas) plus three or

four temporary mining operations (camps) elsewhere, and one or two barge-based marine placer mining and dredging operations. Payroll and direct purchases and services in the area, computed at projected 1990-dollars, will provide an economic input of between $25 and $45 million per year during the peak years of production. Based on the size of ore bodies found in similar geological conditions elsewhere and on present data, we judge that, at optimum extraction rates, mining will only last about 20 to 25 years. It may be only slightly extended, depending on foreign imports. In viewing the probable technology of the 1990s, pollution is most likely to relate to shallow marine habitat changes, and only in the shallow (up to 100 ft.) waters of the Sound. There will be, in the case of gravel-size gold placer tailings, an economic trade-off, as the gravel tailings would be a commodity for ready markets in the local communities and for construction use, thus, eliminating extraction on forest or scenic lands.

SPECIFIC ENVIRONMENTAL PROBLEMS

One of the most difficult problems likely to occur will be the disposal of very fine-grained mine tailings. These are the crushed tailings in the 100 to 300 mesh (ASTM) size. They are readily dispersed by even weak currents. Nonetheless, it may prove better to dispose of such tailings in the deeper bathymetric sinks of Prince William Sound than to allow them to accumulate on land.

Another disturbance is that of changing the seafloor substrate. This change can be caused from either mining the seafloor and redistributing the sediments, or from dumping land mine tailings into a local coastal regime. In either case, the effect must be considered prior to actual operations.

In order to provide local water supplies for mining operations and potable water for employees, some small streams near shore will, by necessity, be dammed. This will reduce the supply of normal river detritus to the local littoral zone. For the marine mining of heavy minerals, chiefly gold, the use of hydraulic mining systems will likely be used, and such systems may capture a few fish and other fauna. If this dredging is done in finegrained, low-energy sediments, principally muds, some iron sulfide in the form of finely divided hydrotroillite may be released into the water column.

We have considered other possible problems, but at this point they are either not relevant to those mineral commodities likely to be mined around or under Prince William Sound, or advanced engineering technology has already provided "clean" operational methods.

CONFLICTS

At this time we would predict only two conflicts within the area that would relate to mining or to extractive gravel operations. In the case of fisheries, there would be some conflict between use of the same area for trawling and mining activities. For seasonal runs of fish, including salmon, mining barges could be moved to other permit areas or simply curtailed during the fish runs. A second conflict could possibly develop between oil transport vessels and mining vessels. Although the navigational tracts are clearly charted and identified for tankers, it is possible that collision of a moving vessel with a stationary mining dredge could occur.

It should be pointed out in considering these two conflicts that marine mining will be limited to waters less than 100 feet in depth and that no mining operations are projected for sites in the present (1978) tanker navigational lanes.

RECOMMENDED INVESTIGATIONS

In considering the several possible investigations that might be conducted prior to the active mining period in Prince William Sound, we have chosen to place our main concerns on those studies that would relate to marine mining or coastal (on land) mining, in that only these mining activities are of serious or long range concern. The four investigations that we recommend are:

(1) Study of Currents. We feel that it is important to be able to predict the dispersal patterns of turbid water and fine tailings distribution resulting from marine mining activities or tailings dumping. Such capability of prediction requires a firm knowledge of the circulation patterns for all of Prince William Sound and for the four seasons. Moreover, special inlet circulation studies should be made at probable gold dredging sites such as in Port Valdez approach, along Bligh Island, and at three other sites.

(2) Geochemical and Sedimentological Processes. We do not yet understand the complex interrelationships between textural components, mineral composition and the geochemical processes operative in areas of potential marine mining and tailings dumping. Without an understanding of the present processes we are unable to predict the effects of new loadings in these critical areas. We recommend that multi-disciplinary investigations be initiated prior to the marine mining period which could start as early as 1985.

(3) Base Line Copper Measurements. The largest mining operations in the near-shore and immediate on-shore areas are likely to be copper mining operations. This is particularly the case at Knight Island and at Ellamar. Such mining will likely release some copper, regardless of its mineralological nature, into the marine environment. Thus, well in advance of actual mining, we should know the baseline values for copper and associated transition metals (chiefly Cr, Ni, Zn, and Pb) presently found in the sediments, fauna and flora of Prince William Sound. We do not believe it necessary to survey the entire Sound, but survey only those areas adjacent to known or projected mining sites with, of course, some geochemical control stations in middle Prince William Sound.

(4) Special Investigations. We suggest that special studies be conducted in the Tatitlek Narrows between Bligh Island and Ellamar, and in Galena Bay. These areas are very favorably regarded by at least four mining companies as potential mine site areas (both on-shore and on the seafloor) within the next ten years. Here we have the opportunity to study and understand highly complex processes that relate currents, ore particles, additives, nutrients, trace metals, sediment composition and water chemistry to the total faunal and floral regime. These could be important bench mark studies for early application elsewhere in the Sound. While other studies in Prince William Sound might be broadly conducted, or limited in parameters and processes, we feel that at these two sites the total natural process must be understood.

PARTICIPANTS IN NON-RENEWABLE RESOURCES WORKSHOP

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RECREATION WORKSHOP RESULTS PRESENTATION

Alan H. Meiners
Park Planner
Division of Parks
Anchorage, Alaska

In summary, our workshop felt that recreation is or is becoming the most rapidly increasing land use of Prince William Sound. When we're talking about recreation, we're talking about a wide variety of use from power boating to wilderness kayaking. I think it's important to keep that in mind, because the variety of those uses create conflicts between recreationists as well as with the environment and with other land uses.

Much of this increase in recreational use will be due to various land status changes in the near future, transportation improvements, boat harbor improvements, increased income and leisure time, as well as many other factors. While Prince William Sound is a relatively large area, which would seem to have a capacity to accommodate many recreationists, environmental impacts and conflicts will occur from this use.

Through proper land use planning and management many of these use impacts and conflicts can be prevented or minimized. However, information on the Prince William Sound ecosystem, as well as recreationists and their activities and impacts, will be needed to meet this goal.

In terms of more specifics, looking at future development patterns in Prince William Sound, at least the recreation group did feel that recreation and tourism will be the fastest growing land use. The fishing industry will be generally stable with possible increases in harvest by individual boats due to habitat and hatchery improvements. Bottomfishing will not be significant within the Sound proper. It certainly will be out in the Gulf, although Homer, Seward and areas such as Yakutat will probably be the basis for those operations. It was also brought up that the irregular bottom conditions in Prince William Sound will create problems for a bottomfishery.

Offshore oil support facilities will be primarily at Seward and Yakutat and not in Prince William Sound. Fish processing may switch from onshore facilities to processing vessels.

In terms of more distant future activities, mineral exploration and possible development of copper and other minerals is certainly on the horizon. There is a possibility of development of Bering River coal, oil and gas resources. It was brought up

that Cordova may have large vessel access problems due to siltation in the future, similar to what Anchorage is experiencing.

In terms of the magnitude of these developments at the community level, facilities for tourism and recreation may possibly create some stable year round employment due to construction activities. However, most of the increase would be large increases in peak summer employment levels, since tourism and recreation industries at this time are generally a summertime activity, although we are seeing increased use in the winter.

There may be a fair amount of land speculation in Prince William Sound should the Native corporations opt to sell or lease their lands upon conveyance. There have been some specific recreational developments talked about by some of the Native corporations, specifically Chugach Regional Corporation. They're looking at the possibility of a historical park center and hotel operation at the Port Etches and Constantine Harbor area.

Fuel docks in remote portions of the Sound are a very real possibility. This will significantly affect the patterns of recreation use and the density of boat use in many areas of the Sound.

The fishing industry will probably have little effect on the growth of communities, with the exception of some construction activities related to facility or habitat improvement projects. Small changes can be expected in communities during mineral exploration stages with possible large changes during development. Logging will be generally a small industry, but it's felt that it most likely will be sustained for some time to come.

In terms of the significant marine environmental concerns, I think recreationists and the tourism industry share a lot of the concerns that other land uses do in having a high quality environment in Prince William Sound and healthy resources. Because of that, oil spills came up as having potentially significant impact on recreation and tourism as well as commercial fishing and other industries. There is a need for MESA in future work to look at spill trajectory, modeling, surface currents, climate data and such.

In terms of recreation and the impacts of recreation it was felt that areas of recreational and commercial vessel concentration should be monitored beginning at the present time with a reasonably low level of use in areas such Eshamy, Long Bay, Shotgun Cove, Surprise Cove and Virgin Bay near Ellamar. The purpose of this monitoring would be to watch for hydrocarbon discharge, sewage waste discharge, a possibility of arsenic problems from bottom paints and debris from boaters, garbage going over the side, styrofoam cups and such. It was

also felt that some bays should be monitored where use is not occurring at the present time to provide a baseline or control.

There is a very strong need for MESA in future research to clearly identify the biologically sensitive areas in the Sound, the areas where more intensive forms of recreation should possibly not occur or be heavily managed as to numbers and times of use.

The problem of direct conflicts with wildlife from boating use brought out a need to monitor birds and sea mammal colonies to determine their existing health and viability and then to watch them in the future. Areas such as the kittiwake colony on Passage Canal already receive disturbance from boaters. Some years back the state ferry used to go by and toot its horn at the kittiwakes to get them to fly up for the tourists to take pictures. I think through Pete Isleib and a few others seriously complaining that has been stopped. There are, however, real questions about disturbance of these species during nesting periods and egg mortality.

There is a very strong need to conduct use surveys. At present there is very little data available on recreation use in Prince William Sound, with the exception of statistics on the state ferries, the Forest Service and public use cabin accounts but there's a real need to get out there and see exactly where people are going, where they're concentrating.

There was felt to be a strong need for overall coordination of recreation management in Prince William Sound between federal, state and private corporations; specifically Native corporations, which would be managing large tracts of private land. There was a great deal of discussion about trails, the need to go into areas and actually build facilities to minimize the impacts to the resource; in other words, you reach a point in an undeveloped area such as a wilderness area where use can reach the stage of serious impact unless you go in with trails, toilet facilities and such. At the same time doing that can stimulate more use and make the problem worse; there is a very delicate balance to strike.

There was a great deal of discussion about the regulation of use of areas and the timing of use. Questions came up regarding the possibility of a large wilderness area designation in Western Prince William Sound, the D-2 process. The group determined that the wilderness status for much of that shoreline may not do a great deal toward protecting the wilderness experience in that area, and this was because of navigation laws and the inability of the Forest Service, who will be the manager of that area, to restrict vessel traffic; for example, having certain days for kayakers and nonpowered craft, while

other days would be open for any type of vessel. This is a real problem and I don't know that there are any answers.

It was brought up that recreational boaters will tend to anchor and recreate in the heads of bays, which are usually the most biologically sensitive areas. Between fishing and recreation there'll be direct competition for the harvest of marine species, with the possibility of overharvesting of marine organisms in the Government's attempt to satisfy both user groups. I think in new hatchery programs raising fish for the sport fishery will be a very important consideration.

The possibility of some slight navigation conflicts exists due to periods of bad weather simply by adding more boats. An earlier speaker mentioned that Whittier is looking at a bond issue this year which would increase the boat harbor capacity to about 400. This is more than doubling the number of boats in the harbor for wet storage. In the long term, with the road possibly to Whittier and another road to Shotgun Cove, Shotgun Cove may well be developed for upwards of 1,000 boat slips. We are, therefore, talking about some very large changes in levels of boat use.

There is also the possibility of direct damage to commercial fishing gear, set nets and such from pleasure boat traffic as well as direct competition for port facilities. However, it was mentioned that fishing is an important cultural or aesthetic interest to recreationists. Pete was mentioning how people come up and ogle at him all the time when he's fishing.

Anchorage pleasure boating may result in making marine service facilities more economically efficient; in other words, they would be sharing facilities with commercial fishing, and we may see more gas docks, repair facilities and such. There is a problem with sport fishermen fishing in areas that are closed to commercial fishermen, such as heads of bays and streams, possibly disturbing a spawning habitat. It was stressed that since we are dealing with people and their impacts, there is a need to educate the people as to some of these conflicts and problems that they may be creating for the ecosystem.

Mining may present some negative visual impact to recreationists. It may also have an impact on the water quality and wildlife, a concern which is common to many land uses. There are possible problems of offshore dredges and navigation conflicts. Mineral development activities may compete in a few small localized areas for shoreline space or anchorages. Wakes from barging can create serious hazards for kayakers and other small vessels.

Timber and logging will have visual impacts on recreation scenic values and other impacts related to water quality and fish and wildlife. Logging will also affect recreationalists.

Probably one of the most interesting areas of conflict, though, is conflicts between various groups of recreationists. We're essentially dealing with intensive forms of recreation versus less intensive, and they're competing for generally the same resource. Those kinds of uses are incompatible with each other; for example, kayaks and speed boats. I don't think we see too much speed boating in Prince William Sound, but I'm sure that somebody's going to buy one one of these days, and it really depreciates the experience of the kayakers who are after a more passive wilderness type experience.

Developments in tourism will likewise possibly affect the less intensive forms of recreation. Sitting in a bay and paddling a kayak and seeing two state ferries and four or five tour boats go in and out again lowers the quality of the experience to the participant. The question of increased power boat use and refueling from the development of refueling facilities, either on Native or state lands, will greatly expand the range of power boats. As it is now in Prince William Sound, the power boats are pretty much limited to a given area, and generally we're talking about out of Whittier. Beyond that, the kayakers can fly in and have the areas pretty much to themselves. If new fuel facilities go in, pleasure boaters will be virtually everywhere in the Sound, leaving no areas of less intensive use.

In terms of information for regulatory agencies, all the information to users, and baseline air and water quality data, will be critical to denote changes from use and to determine regulatory measures for correcting problems. Climatological data, including current, wind and wave patterns, will be needed to predict potential hazards from oil spills. There is quite a problem in the Sound with inexperienced or novice boaters putting their boats in at Whittier, either going out and running out of gas or going up on the rocks, getting into some kind of problem and having to be rescued by a fisherman, if there is one around. It is felt that there may well be some deaths in the future if there is not some intense public education effort undertaken.

Industry will require data for facility planning in determining operating needs. I think industry will definitely need to know where the sensitive areas in the Sound are. Those areas will most likely not be permitted to be developed. As it stands now, industry seems to think that somebody's going to shoot at them for damaging one aspect of the environment or the other. If through coastal management or other land use planning efforts, suitable areas for various industrial developments can be determined and identified early on, industry will be in a much more stable position as far as planning.

Any questions? Yes, Pat.

MR. WENNEKENS: I'm Pat Wennekens. I work for the University of Alaska. I had two comments in terms of controls. I feel that there are precedents, you know, there are areas where power boats and such are restricted, I think, in the Yosemite--I mean in Yellowstone and stuff they only allow canoes or--so there are means of controlling things once you decide, you know, how the area should be isolated.

MR. MEINERS: If I could interrupt. I think the problem there is we're dealing with marine waters and navigation laws, international agreements. I may be wrong, but with the Coast Guard.

MR. WENNEKENS: Well, the second comment I want to make was that under the (indiscernible) program there are mechanisms by which you can essentially select areas for certain types of use and saying the control should be so and so, so I think we have the control if we apply ourself to it. One thing that wasn't mentioned was the problem of--the present problem and the future problem of aircraft traffic through the area if you increase a lot of activities. And, well, this is basically the two comments I had on it.

MR. MEINERS: Thank you. Any others?

MR. GALLIETT: I'm, Harold Galliett, consulting engineer, and I have a few comments on the program that I've heard so far and what was reported in the paper. I think the biggest impact on Prince William Sound in the near future is going to be the population of Anchorage. I'm informed by one of the members of the assembly here that the Municipality of Anchorage now has half of the population of Anchorage within its boundaries. This is quite a number of people. We're being more and more crowded into the same space. And I personally, from 24 years of observation, feel a pressure on my recreational freedom and will do what I can to relieve that pressure.

It seems to me from my studies of transportation and the fisheries industry that some kind of a fisheries subport is needed in the far corner of Prince William Sound as far distant from Seward and Cordova as possible. We're making some long runs to collect fish and a

new community, a subport, not necessarily a full-blown community is needed, to support the fishing industry. If that happens to support recreational boating with fuel, so be it.

On transportation the figure of $20 million was given for a cost of a highway to Whittier. I just recently completed some work in that connection and conclude myself that the figure, with normal standards of construction, will be more like $45 million. Unfortunately, the condition of the pass is such, with high winds and extremely heavy snowfall, that much of the road will either have to be tunneled or covered by some kind of artificial snow sheds to protect it from slides and extremely heavy snow. Even then the road maintenance will be difficult and the travel in the wintertime may be hazardous. The Cordova Road was quoted at $100 million. I think this whole subject needs considerably more study. It depends upon how much of a road is built, whether it's pioneered through for recreational use or whether it's intended as a highway for normal commercial purposes.

One thing I have observed myself in my travels through Prince William Sound is the impact on game. During certain seasons of the year the game is very restricted in its location, and there seem to be a lot of people misusing the right to hunt and fish in the area, particularly to hunt. The slaughter of game under certain conditions can be very serious, and I think that's going to be one of the big problems.

Another thing I haven't heard too much about is care and maintenance of recreational areas. It seems to me that there is an implicit assumption here that recreational areas will be used and somehow they will remain wild and untouched and undirtied. I've seen it around the state. I think the planners on recreation have got to plan on some maintenance of these areas. They can't merely leave it to the public to maintain the areas that they use. Ignoring maintenance requirements would have a severe damaging effect.

Finally, I think that I hear a discussion here of regulation. I hear discussion of management. And these, to me, mean restrictions on my freedom. I hope you folks will keep in mind that there are a lot of people who maybe don't have such an esoteric viewpoint of this; they simply regard their right to go into the country as they want and they don't want it restricted. And I don't either.

RECREATION WORKSHOP SUMMARY

Recreation and tourism are the most rapidly increasing use of Prince William Sound. This increase in recreational use of the Sound is due in part to: changes in land ownership and management, boat harbor expansions, transportation improvements, as well as increased income and leisure time of both Alaskan residents and visitors to the state. While Prince William Sound is a relatively large land and water area with a capacity to accommodate many types of recreational uses, environmental impacts from recreation use and inter and intra resource use conflicts will occur. Through proper land use planning and management, based on a thorough understanding of the area's natural and socioeconomic systems, many of these conflicts can be prevented or minimized.

WHAT ARE THE PRESENT AND FUTURE DEVELOPMENTS OF INDUSTRY AND RESOURCES IN THE PRINCE WILLIAM SOUND REGION?

Of the various resource related uses of Prince William Sound, recreation and tourism are probably the fastest growing uses of the area. At present, the main recreational use of the Sound is by boaters. The majority of these boats are privately owned motor-powered craft. However, the number of sailboats and kayaks appears to be increasing relative to motor-powered vessels. Ferries of the State Marine Highway System as well as private charter sightseeing vessels annually transport large numbers of sightseers through the area. It is expected that the increased use of private recreational vessels will encourage the development of additional support facilities or the expansion of existing facilities such as harbors and fuel stations.

Commercial fishing will probably remain stable within the Sound. However some increased harvest may be expected due to several private and public fisheries enhancement efforts currently underway. Development of the Sound's bottomfishery will probably not occur as problems are posed by the irregular conformation of the Sound's bottom. Some use of floating fish processing stations may be seen in the future. Several specialized fisheries, such as harvesting of snails and herring roe on kelp will continue to be developed.

Petroleum developments will focus on the transshipment (and possible refining) of North Slope crude at Valdez as well as onshore bases for exploration and development of the Northern Gulf of Alaska. While onshore bases may not be developed in the Sound proper, sites in proximity to the Sound such as westcentral Kayak Island, or Port Etches may be utilized by industry. Sites identified by the State of Alaska as potential bases within Prince William Sound include Windy Bay/Cedar Bay on northwest Hawkins Island and the historic copper mining town of Latouche on the northwest shoreline of Latouche Island.

Increased tanker traffic in the Sound will occur as the Trans-Alaska Pipeline flow rate is brought to its designed capacity. Mineral exploration will continue and possibly intensify in the future. Should mineral resources prove economically exploitable, mining will probably be done offshore from floating platforms with the use of hydraulic equipment. Some land based mining may occur with concomitant docking and shoreline transfer facilities. Future increases in the price of coal may render the Bering River coal fields economical. The development of these fields would most likely necessitate a road spur off of the Copper River Highway to this area.

The management and harvesting of timber resources in Prince William Sound will probably be a permanent but relatively small industry.

Some development and sale of real estate for residential and recreation home sites is expected to occur after Native corporations receive title to lands selected under the provisions of the Alaska Native Claims Settlement Act (ANCSA).

In summary, the current industry and resource uses of the Prince William Sound region are:

Petroleum transshipment.
Fishing.
Fish processing.
Recreation and tourism.
Timber harvesting.

Future industrial and resource use activities are expected to include an expansion of the above industries and:

Mineral exploration and mining.
Development of Bering River coal reserves.
Real estate development.

WHAT ARE THE EFFECTS OF DEVELOPMENT ON POPULATION GROWTH AND LOCAL ECONOMY?

The expansion of recreation and tourism uses of the Sound will result in the development of support facilities and some highway and trail construction. The provision of these services will have social, economic and natural system impacts on the region. It is expected that the permanent populations of Prince William Sound communities will increase on both a seasonal and year round basis due to the provision of such services. The current effort by the City of Whittier in attempting to have a road constructed, connecting Whittier to the state's contiguous highway system, is an example of recreation and tourism related services. The construction

of this road could result in a dramatic increase in recreational use of the northwest portion of Prince William Sound.

A historical park/resort has been proposed in the Port Etches/Constantine Harbor area by Chugach Native, Inc. This facility would be established at the site of an old Native village. Large scale remote developments such as this would have indirect economic and social impacts on communities throughout the Sound.

Commercial fishing and fish processing is already well established and will probably have minimal additional effect on the human population and economy of the area.

The development of offshore petroleum deposits, mineral exploration and development, timber harvesting and coal development will all potentially result in an increase in local populations and possibly strong effects on local economies.

WHERE ARE THE MARINE ENVIRONMENTAL CONCERNS SUCH AS POLLUTION, ALTERATION OF NATURAL HABITATS, OR CHANGES TO THE NATURAL POPULATION ORGANISMS ASSOCIATED WITH THE DEVELOPMENT OF PRINCE WILLIAM SOUND?

Associated with the increase in recreational use of Prince William Sound is the possibility of increased water pollution. This water pollution will be in the form of litter and debris from boaters, gas and oil spills (primarily at fuel docks) and the introduction of toxic compounds into the marine ecosystem from antifouling bottom paints. While fecal discharges will occur from marine toilets, it is not expected that significant pollution problems will result. The tendency of recreational boaters to anchor at the heads of bays which are often biologically sensitive (eel grass beds, etc.) may result in adverse impacts to critical marine systems. Noise from power boats may disrupt sea bird rookeries, sea lion rookeries and other critical wildlife areas. All of these factors may potentially decrease the quality of upland and marine wildlife habitats. Should a loss in habitat values occur, a decrease in some wildlife populations could be expected.

Commercial fishing, if improperly managed, could seriously deplete natural fish populations from over-harvesting. In terms of water quality, commercial fishing vessels may be expected to continue to be a major source of litter and floating debris and may generate similar impacts to those of recreational vessels.

The major petroleum industry related impact is clearly the potential of an oil spill. It is expected that many small

and intermittent spills will be avoided by efforts such as the current ballast water treatment plant at Port Valdez. Should a major oil spill occur, the extent of its impacts upon Prince William Sound will depend on a number of factors. These factors include the location of the spill, the size of the spill, wind, currents, and the time of year.

Mining activities could have a localized but adverse impact upon specific areas. Adverse impacts which could be expected from mining include increases in turbidity, the introduction of toxic heavy metals and the loss of kelp beds through dredging. However, through proper planning and management these impacts could be minimized.

It is expected that the principal harvesting method of timber will continue to be clear cutting. Clear cutting may have adverse effects upon certain wildlife species and watershed values. The adverse visual impacts of clear cutting are obvious.

WHAT ARE THE MAJOR RESOURCE-USE CONFLICTS?

Recreation vs. recreation: Different forms of recreational use may conflict with each other. An example of these is nonpower boats (e.g., kayaks) objecting to the use of power boats in specific areas. These users often feel that power boats destroy the tranquility that they (kayakers, canoers) are seeking. Power boats may also pose some safety problems for nonpower craft. Intensive recreation uses and the development of recreation and tourism facilities along with increased accessibility of the Sound may diminish wilderness aspects such as the wildlife and solitude which many recreationists seek.

Recreation vs. fishing: The introduction of additional recreation use in Prince William Sound may increase competition between commercial and sport fishermen. Through intense competition between sport and commercial fishermen, the potential of overharvest and depletion of certain fish species may increase. In harbors, commercial and recreational vessels will compete for moorage space and various marine services. Some commercial fishing gear may be susceptible to damage by recreational vessel traffic. Increased pleasure boating activity with presumably many inexperienced skippers will increase the incidence of commercial fishermen having to assist recreational boaters in distress.

Recreation vs. petroleum industry: Tanker and pleasure boat traffic may result in some navigational or aesthetic conflicts. Should an oil spill occur from the use of Prince William Sound by oil tankers, the impact on aesthetic values would be dramatic. Adverse impacts from an oil spill on fish and wildlife will likewise affect the recreational and aesthetic value of these resources.

Recreation vs. mining: Some mining activities may present a negative visual impact to recreational boaters. Should mining result in water quality and wildlife impacts, to many the recreational experience may be diminished. The operation of offshore dredges may create navigation hazards during poor weather conditions. Mineral development activities may compete with recreation use for harbors, anchorages and shoreline space. Wakes from barges and large vessel traffic may create hazards for small boats and kayaks.

Recreation vs. timber: In most cases, timber harvesting will visually detract from the scenic beauty of Prince William Sound. Should erosion and subsequent siltation occur from harvesting, adverse impacts to sport fisheries may occur. Timber harvest will impact wilderness character and values.

WHAT SORT OF ENVIRONMENTAL INFORMATION IS REQUIRED TO DEAL WITH THESE CONCERNS BY:

Regulatory agencies?

1. Baseline air and water quality data in order to determine changes from uses and regulatory corrective measures.

2. Climatological data (currents, winds, etc.) to predict potential hazards to boaters.

3. Recreational use level statistics to determine potential impact areas.

4. A determination of sensitivities of various marine ecosystems to use-induced stresses.

Industries?

1. Data for facility planning and determinations of the least harmful location for facilities.

2. Systems sensitivity data for mitigating impacts during facility planning.

3. Bathymetric, current and climatological data for facilities siting, design and operation needs.

Scientists?

1. Baseline systems data for conducting research.

2. Research coordination (informational, sponsor conferences, etc.) and information exchange/transfer services.

The Public?

1. Improved navigation charts.

2. Information on system characteristics and sensitivities (to increase the public's environmental awareness).

3. Identification of currents, weather and other hazards.

4. Information on resource availability.

5. Information on proper outdoor behavior and ethics.

6. An atlas of environmental/cultural features of the area.

PARTICIPANTS IN RECREATION WORKSHOP

NAME	AFFILIATION
Lynn Mitchell	Chugach N.F.
Charles K. Weaverling	Kayak Guide
Eric Singer	Kayak Guide
Joan Foster	MESA
James L. Wise	AEIDC, University of Alaska
Alan H. Meiners	Alaska State Division of Parks
Kevin Hekrdle	Heritage Alaska, Inc.
Philip Munger	Harbormaster, Whittier
Virginia Bender	Council Person, Whittier
Bob Childers	Childers Associates
Michael Crane	EDS, Anchorage
Barney M. Meyring	Parks & Recreation Comm., Valdez

RENEWABLE RESOURCES WORKSHOPS RESULTS PRESENTATION

Richard J. Rosenthal

As you might imagine, we had a show on our hands. We were dealing with everything that's renewable in Prince William Sound, the living creatures from the forest and the alpine terrestrial meadows to the marine environment. We had a large gathering in excess of 50 individuals. The ranks would swell and decline, depending on people's attitudes. We had some active individuals, some strong minds in here, that weren't going to bend on certain subjects. We had individuals from a wide spectrum. We had current researchers in Prince William Sound on the marine environment, logging interests from the U.S. Forestry Service, we had the Coast Guard represented with Commander Purdy, we had commercial fishing interests and Native community interests. I don't think you'd see that often. It is a very viable approach, I think.

We decided right off that this was going to be a chalk talk, sort of a strategy session, and not really get into taking apart the biology of Prince William Sound. I think in the first day we led off with lumbering, forest products. Clay Beal discussed some of the U.S. Forest Service interests, their proposed timber sales, some of the areas that they will be active in or where they are currently active, in Prince William Sound. They've agreed to provide us with some materials on just where these locations are and where we may expect activities, potential impacts, etc.

We didn't realize it but Commander Purdy, who's in charge of some or all of the traffic problems in Prince William Sound, was only going to be with us for about a day, so he consented to discuss the marine traffic lane in the Sound, and gave us a really good background on what we're dealing with. This is one of the major impacts, as we see it, on renewable resources. We're talking about daily large ship traffic into and out of the Sound through it's major artery, Hinchinbrook Entrance.

For your own information, that traffic lane, as I understand it, is about three-quarters of a mile wide. It's currently enforced by large ships reporting in to Port Valdez. They're picked up when they enter Prince William Sound in the Hinchinbrook Entrance itself.

The Coast Guard is in real need of having a risk analysis, a document of sensitive areas, time sequences, in the event of catastrophic damaging to one of the tankers. And it's a really heavy chore because the Coast Guard is not only just

concerned with the marine environment or the terrestrial environment, but also with the lives of the men and the vessels themselves. He's determined they'll make a decision. They're not going to let that vessel break up or discharge in Prince William Sound staying at anchor in the central part of the Sound.

I think the first thing biologists would think to do is to take the tanker into Port Valdez where there's already some contamination and a lot of human disturbance. Because of hazards and fire and interaction with other vessels and ships and onshore facilities, that's not going to happen. It's going to go to some embayment or combination of embayments in Prince William Sound. Commander Purdy and George Perkins of the National Marine Fisheries Service are attempting to work out this risk analysis, sensitive area mapping. They just don't have all the necessary information at this time. They need more.

Tentatively they've selected Jack Bay just south of Port Valdez and Port Etches as two of the sites to bring a damaged tanker to for containment. Right away I could see a potential conflict with the Native groups talking about building a historic center in Port Etches and Constantine Harbor. And a lot of biologists came up to me later and said, how can we persuade them not to take something into Port Etches and Constantine Harbor, because of the "richness and diversity of species" found in those estuarine systems. This is what we're dealing with and it could happen tomorrow, tonight, a phone call and where do you take the tanker? I think that all the people who live in Prince William Sound and do a lot of water related activities feel it's going to happen, it's just a matter of time. Are we prepared for that event? I don't think we are right now biologically, in terms of researchers providing information.

Next Dr. Hiatt presented five points which he felt we should address in this workshop in terms of considering the resources study. The five points were: (1) an inventory of species, to include growth, composition and interactions of those major species in the marine nearshore and onshore environment; (2) developmental potentials and activities that would be involved in the Sound; (3) environmental hazards we might consider and deal with and discuss while we're talking about these other two points; (4) priorities for development and protection; and (5) conflicts, both real and future that we may be dealing with.

Next I thought an interesting point was raised by Frank Williamson of the OCS Program. He said that based on his backgound and experience in more protected inland waterways, such as Chesapeake Bay, we have here a very real highly

appealing opportunity to study a pristine environment such as Prince William Sound. He feels that this information may actually be able to be used in a decision making process.

We discussed briefly the boundaries that would encompass Prince William Sound if there was a fundable study. We're talking about a big chunk of real estate and thousands of miles of coastline in that small waterway, an inland sea. It is an inland sea with some circulation at the ocean entrances, in Hinchinbrook and Montague Strait, Latouche Passage, etc. What is certainly needed is circulation information from outside and nearshore where major populations of marine life might be moving into the Sound. We could not totally neglect that band around Prince William Sound that we call the Northern Gulf of Alaska. It's not a closed system; there's tremendous interaction between the Northern Gulf and Prince William Sound.

That was our rough boundary, let's try to stay within the Sound proper itself and not stray off down to Juneau or to Middleton Island if we can help it.

The consensus was that we had some research priorities. These are not in terms of priority ranking, but the first three are a catalog of knowledge or an atlas about the living marine resources of Prince William Sound, both past research activities, past observations, and current ongoing studies that are not showing up in bibliographies, but more than just a listing of who's done what, what agency.

We feel that it's important to actually have onsite interviews with commercial fishermen and naturalists who enter the Sound and leave with their information in their notebooks. I know from living in Cordova for three or four years that an awful lot of people stray into the Sound and they're out there walking around the rocks and working on the beaches. It's just for their own information and they go back to California or New York, and this is not in the literature anywhere. Interviews should also be held with Native communities and the townships for their input. What is their knowledge about the Sound? These people have lived for centuries on those shorelines and have interacted with the marine and terrestrial species, and they have a wealth of information.

In many cases the information from a card-carrying researcher is just not enough for the guy on the street or the commercial fisherman. I know from trying to transcend both when we work along the docks and rap with those guys they may suddenly realize that what we're doing is not going to just end up in a gray report that's thrown in the trash; maybe

that information can be helpful to understanding those resources. We feel this catalog is needed right away. We're certainly aware of some other activities from within the state and out of the state to prepare annotated bibliographies, but we think it should be a different approach.

The second thing that we recommended was reconnaisance surveys. I think some of the individuals came here with the feeling that this is not the approach. And maybe it's the words reconnaisance surveys that have agitated some other funding agencies, but we couldn't come up with another title. What we could do is define how we would conduct a reconnaisance survey. We have people in here that are really experts at reconnaisance surveys. We have two different types of surveys. These individuals felt that the first items in these surveys were gross inventories and species composition; whether or not they're beachlines or below the sea surface. Our maps, our current status of knowledge is not good enough yet to jump into a major research program. We need this nature walk around Prince William Sound.

Under these reconnaisance surveys inventory and species composition, identification of some of the dominant species in those assemblages, information on whether it's a clam, mussel, sea urchin, sea otter, etc. needs to be compiled.

The naturalists' recording observations, not just counting all the creepy-crawlers along the beachline and saying there are 48 limpids on that rock, need to be included for that initial reconnaisance survey. If an eagle swoops down and takes a seagull at our feet, we're going to record that information, and it's going to start to build on our understanding of trophic dynamics so that we can say, that's the way energy flows in the system. We can then begin to design our programs with that background data.

Also to be included are basic hydrocarbon baseline measurements. There are some programs underway right now in Prince William Sound. Their funding, as I understand it, is question marked. They should be continued so that we'll have an approximation of background levels of hydrocarbons in some of the plants and animals and sediments, water column, etc. By that means we can see if the environment we're trying to describe and trying to protect is being degraded and then we can point a finger because a significant buildup of hydrocarbons has occurred over "X" number of years.

Our emphasis in these reconnaisance surveys should be on process orientation and energy flow. When the investigators come back from the field, we have this step two. Now, what would we do with that?

We felt that the third priority item in our research project was with that information. With the catalog of knowledge and the reconnaisance survey work underway, we would prepare an identification of critical habitats and locations, the seasonal components and types of impacts that might be involved, i.e., logging, oil transportation, fishing, effluent, sewage, cannery wastes, etc.

This data then will suddenly start to flow to the Coast Guard and the bureaucrats, the resource agencies, the communities in the Sound, so they can see where this data is starting to go.

Then comes the real nitty-gritty, the nuts and bolts types of studies, what we're calling the process oriented studies; to see how this system ticks. As you can see, we've borrowed this buzz word from some other agencies and their programs, such as OCS, this is the way they're finally going. We've had a learning experience. Three or four years ago we felt that this is the way the study should go for some of these research programs in Alaska, but they weren't at that stage yet. Maybe some individuals had to burn themselves up and money had to be spent to take this giant step to where we are now. It's a giant step for Alaska, but it's just a baby step in terms of our knowledge of coastal dynamics and nearshore processes. We don't really know a lot about the nearshore marine environment.

Under these process oriented studies we feel that even if we get our catalog of knowledge or the atlas going, and have done the reconnaisance surveys, we're going to need primary production information. We'll need primary production information from the plants; the attached seaweeds, seagrasses or the macrophytes, as they're termed, the bacteria, benthic diatoms. Howard Feder mentioned that we're getting these algal mats that are very seasonal and are probably extremely important to things like juvenile salmon in terms of not only seeking cover but feeding upon some of the prey species that sit on these algal mats like benthic copepods.

Scientific thinking is finally coming around to the idea that planktons are not the only important chow for this island sea, but that much of these food organisms and prey species are dependent upon living substrate. Hiding on a rock, on a seaweed or on a diatom what looks like scum to a casual observer, under a microscope is a microscopic plant. Primary production information indicating just how much carbon, how much energy is going into that body of water is necessary.

We feel that Prince William Sound is a heavily based detrital system from wetlands, terrestrial meadows, forests, debris from

logs, the woods, as well as the breakdown and shedding of the algal canopies, the seaweed beds and seagrasses. All of these things are essentially starting to build and feed the system. Instead of thinking that the seaweeds, bark debris and a lot of other things are bad for the system, researchers around the world have come to the conclusion that the production is coming from the coastal zone; the plankton may be a minor component. It's a very seasonal component, where as these other things are getting constantly pumped into the system from terrestrial meadows, all the small streams that feed into Prince William Sound, and the extensive shoreline. There's a band of seaweeds and seagrasses and benthic diatoms and bacteria that range from the shorelines all the way out into deep water benthos.

The need is immediate for the primary production information. If you lose that facet of the food chain, of the ecosystem, you're not even going to have one. We don't have that information. It's very seasonal, very spotty, and we are not aware that there's anything available on seaweeds and seagrasses from the Sound, and we probably cannot extrapolate from other areas. We need different types of information on primary production than what is available, mostly long term or seasonal stuff.

What about the habitats or assemblages we've studied? We think that MESA's involvement should not run up into the woods. That's probably the jurisdiction of another group. That information is needed to fit into the overall catalog of knowledge, but granted with a limited amount of monetary and human resources, we'd better stay down in the lowlands. The first spot we'd probably look at would be the wetlands, the salt marshes, salt water lagoons, that are found in most of the headwaters of all of those embayments in Prince William Sound.

The next habitat assemblage we feel should be considered is the intertidal zone, the beach zone. It is highly visible, it's known to be one of the first to show consequences of a floating contaminant like oil, human disturbance, etc. Because the rocky intertidal makes up so much of Prince William Sound, the intertidal zone is going to be the major habitat. However, we should not neglect the mud, sand and gravel types of substrates at the heads of the bays that seem to be so productive.

As you can see, we're taking on a community or assemblage in the Sound. Many investigators would be critical of that, saying that we're not going to get very far with community studies; they're too difficult, they take too long. There's another school of science that says that is the approach you

take for this kind of research program; that everybody can't be off doing a little single species study, because it'll never fit together again.

We're going to have to give something up to get something. We're going to give up really strong definitive data on single species and everything that species does from the time it emerges from the egg. We're going to give that up as a trade off to understanding how it functions in a little system and how it functions in an assemblage. For instance, in the rocky intertidal what does that periwinkle do, that limpid, that starfish, that seagull, etc.? What are some of the seasonal changes that take place?

The next habitat we considered was the shallow subtidal zone meaning from the zero elevation of the tide or mean way low water out to about minus 30 meters below the sea surface. This zone has been very difficult to study in terms of biology because classical, conventional biological sampling gear just hasn't worked in this area effectively due to shoal water, dense vegetation and rocky irregular bottom.

Within those shallow subtidal zones we recommended that we study protected macrophyte beds, these seaweed, seagrasses, because they're so conspicuous. That one component of the system probably dominates it. The other topic was exposed macrophyte beds, the kelp forests that might be in Hinchinbrook Entrance or Montague Straits or off Naked Island.

The next category was the subtidal benthos, that habitat greater than 30 meters below the sea surface, out to the depths where we're suddenly picking up a multitude of commercial species, bottom dwellers such as the crab and shrimp, bottomfishes, etc. Since the soft bottom benthos and soft sediments can be studied by dragging a trawl over them or taking a bite out of the substrate or dropping a television camera down or working with commercial fishermen who are extracting living resources out of that system, that type of habitat is approchable.

The rocky deep water benthic areas should be looked at, but we're uncertain about how well to sample it. That may be more observational, i.e., underwater television cameras, etc., more qualitative, just descriptive information.

The next broad assemblage we wanted to consider was the plankton, the water column animals, those floating plants and animals that live in the water column. In some areas we feel we can extract information from other parts of the world, but data that is very critical, which Doug Redburn brought up, are the day/night investigations. If all of our sampling is confined to daytime, the plankton may be down along the bottom, and you've got a tremendous amount of biomass down there. The predators, such as shrimp, pollock,

etc. are working on that plankton, and at night the whole patch is rising up near the sea surface. It's highly vulnerable to a floating contaminant at that time. Most of the sampling is during the daylight hours but here's one thing in biology we can sample on a day/night basis.

That's no doubt a big chore. We come back to our catalog of information and start looking at it and begin these broad base studies and we look for all those data gaps. Then we get down to the species specific types of investigation, the single species population studies. For example, if we didn't have enough information about a mussel or crab and we needed more to fit into our overall picture of Prince William Sound.

Suggestions from Pete Isleib and Mimi Sangster were the key species food habits for marine birds. That information is needed and we don't have it, and we probably can't extrapolate from other areas. The role of groups of things like nearshore fishes, that swim along this shallow water or are present in those zones at certain times of the year, such as juvenile herring, capelin, sand lance, juvenile salmon, greenling, rockfish is totally unknown in Alaska. Research has been directed at the five or six big species of commercially important fish. That list could go on and on and on. From that we'd just have to select which ones we need right now given five years of research time or whatever.

The final thing naturally is effect studies. We have the ecosystem and it is nice now, but how will this be affected? With the effect studies, we certainly need nearshore oceanographic studies, circulation studies. Should there be a contaminating event where would it move to, where would it be confined to? What area of the Sound might it disturb? This means anything from a dredging operation, ship discharge, to a tanker leaking, whatever.

These effect studies would certainly look at the impacts, like oil transportation and lumbering, and reexamine the great Alaska Earthquake of 1964. We have this incredible event which took place in Prince William Sound in 1964 and dramatically disturbed the biota. The researchers who worked on that post survey recommended a number of studies to be followed up. I don't believe anyone has heeded those recommendations and followed up on those studies. I know that A. J. Paul at the University of Alaska has done some follow up studies on clams in certain areas. To study the event that took place and so changed the intertidal zone, that's an effect type study. Let's see what those assemblages look like after Mother Nature shook, uplifted, created submarine landslides, etc.

This is the experimental approach when we would go to oiling experiments, clearing of patches. What do you do, what happens if you disturb the system? What do you get in five years? Maybe nothing. You can get a bare piece of rock, maybe a diatom scum. Through all of this we're stressing the dynamics of the system, it's a living, breathing, ticking system that interacts with the land and the water.

I would like to thank the many participants. I got to know some of the people and I learned a lot from their ideas. We have some researchers in Alaska who are really starting to contribute and some community people who are laymen as such, but are outstanding observers and can start to contribute, too, if they're given an opportunity to tell what they know about a particular fish or bird.

Thank you. Are there questions?

MR. WENNEKENS: I found your comments very interesting, and I think that some of the subject matter that you people discussed was essentially quite significant in terms of the overall aspects of how should we gain knowledge of an area from which we might know or we think we have insufficient information. And I've no qualm about, you know, the intent of the people that were participating in this in terms of acquiring this knowledge.

My comments are that we were given a format for this workshop to address some questions. And I would like to question if those questions have really been looked at. My reaction to what I hear is that, oh, yes, we have a problem, we need more studies and after those studies we'll tell you a few things about the system.

My first question is that what knowledge do we have now we can apply to help the people now? We have -- we are not ignorant about those areas. Maybe we don't have the knowledge specifically for the area, but we have knowledge for things that can be related to this. And I think the big question is what can we use that we know now to help the people that need the help. And I don't see this kind of transpiring right now out of this -- out of this discussion.

MR. ROSENTHAL: Pat, if I could interrupt you on that. I feel that our point one on our cataloging of events, our cataloging of information, is that approach. We're not talking about taking 10 years to put that atlas together;

we're talking about grant funds being available. My colleagues tell me there's a lot more information, and I agree with you, right now that's known about Prince William Sound. And that that could be just assembled within, say, this fiscal year or very quickly. It would not be something that's going to take 10 years for the data to be available.

So I would say that we actually did address that problem.

MR. WENNEKENS: Well, I would not argue on that point. I'll talk to you over a beer on this. The second question, I think, was on part two, on vital concerns such as pollution, alteration of natural habitat or chance natural propagation of organisms.

My personal feeling, I would regard that we have already one major impact in Puget Sound that hasn't been talked about, fisheries. Fisheries can remove more population out of the system than an oil spill right now. And I think we have to look at the ecological effects of what fishing does; the status of our fisheries and how the increase of fisheries is going to affect the ecology of the system. I'm taking this pragmatic point of view. People say oil spill is bad and fishing is good, and I think we have to look at other priorities on this.

Another item that's come into being, what is the relative importance of the concern in terms of what affects the marine environment? Well, I think that we have specific concerns right now. Fishing is one, the hatcheries problem is another one, shipping of oil is one, logging is one, recreation people is one and transportation is one. And I don't see, on the discussion we have, on how we relate the kind of information gathering or the application of information to those things we already know are happening.

One last item is on part five on your workshop frame. You say that what sort of environment function is required for regulatory agencies? I would like to really put the question that EPA, the Coast Guard, the ADC, all regulatory agencies, have a set of stipulations that by law they want to impose upon the industry. My argument is, are those stipulations meaningful

to environmental protection? Or are they just numbers that are generated in some way? And I think the scientific community has to challenge maybe the validity of some of those numbers for the kind of protection that is expected from them. And I think this is an issue -- this is a very important issue and should be addressed by the biologists. What does our stipulation on turbidity mean in terms of biological protection? I ask you that question and try to answer it. And why should you ask the people to spend a lot of money if they have no meaning?

The industry, I feel, should be a partner -- a very close partner to this. And I see a -- maybe a couple of people that could be classified as the industry side. But certainly I feel that they are kind of missing in this thing.

The scientists, I have no qualms, we know what -- we -- all the same bodies usually go to the same meetings and talk about the same things. But so there's no question in here. But in the scientists' community I would say that you have a very important community of scientists and those in the consulting firm. Those people also have some knowledge that could be applied to look at specifically other problems. From the public side, I think they might be confused about what this is all about. But I think from the public side we should also lecture on how this kind of data gathering is going to specifically address itself to the problems and not just to talk about, to my feeling again, well, we have a problem; we need more studies, that type of thing. Thank you.

MR. HADLEY: Are there any other questions or comments?

MS. MARX: I'm Jean Marx and I'm with the Southcentral Water and Related Land Resources Study, which is a water resources council study for Southcentral Alaska. Prince William Sound is an integral part of that study, although it certainly won't have the emphasis -- we don't really feel it has all the problems and issues that this study is to address. However, I come for two things. The agency is a cooperative among federal, state and local

entities, all working together to come up with strategies for Southcentral Alaska until the year 2025. Therefore, I'd like to offer any of the work that's going on there to this group. They could look into it and see where the gaps are and what's proposed by the various committees.

The committees in the studies consist of an economic task force. Like I say, keep in mind that these are all federal, state and local borough, municipality, people working on this project. The various committees are Fish & Wildlife, Water Quality, Water Supply, Land Use Management, Electric Power and Recreation. The Gulf of Alaska, including Prince William Sound, is included in this work.

If you have any questions feel free to call us. Furthermore, we'd like to request that we be placed on the mailing list and that we be kept informed throughout this study, which is to 1983, of all of the ongoing proceedings. Thank you.

RENEWABLE RESOURCES WORKSHOP SUMMARY

TRANSCRIPT OF RENEWABLE RESOURCES WORKSHOP

Edited by:

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and

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A FRAMEWORK ON WHICH TO BASE PRINCE WILLIAM SOUND ECOSYSTEM STUDIES

I. Catalog of present knowledge of Prince William Sound

- A. Survey published and unpublished reports
- B. Identify on-going studies by state and federal agencies and universities, private industry, fishing corporations, consulting firms
- C. Survey local knowledge by interviews

    1. Commercial fishermen
    2. Subsistence fishermen
    3. Sport fishermen
    4. Naturalists/long-time residents of Prince William Sound.

II. Reconnaisance studies

- A. Examine and confirm following habitat types considered of principal importance

    1. Intertidal zone

        a. Wet lands and salt marshes
        b. Rocky shores
        c. Cobble and sandy shores
        d. Mud flats

    2. Subtidal zone

        a. Shallow subtidal (to -30 meters)

            (1) Unprotected rocky bottom (mainly ocean openings)
            (2) Protected rocky bottom (embayments and fiords)
            (3) Soft sedimentary bottom

b. Deep water (below 30 meters)

(1) Rocky or boulder bottom
(2) Soft sedimentary bottom

3. Water column (offshore and nearshore - pelagic habitats)

4. Supratidal (terrestrial zone)

Transition zone between intertidal and terrestrial habitats - ecotone

B. Identify dominant or key species and populations of each physical habitat

C. For each key species collect the following information:

1. Distribution throughout Prince William Sound ecosystem

2. Estimate relative abundance (density and biomass)

3. Biotic interactions, especially energy pathways within the ecological subsystem characteristic of the major physical habitats

4. Biotic interactions with adjacent subsystems and with Prince William Sound ecosystem as a whole

D. Evaluate primary production and standing crop (seasonally)

1. Primary production by phytoplankton considering nutrient cycling, water temperature and daylight

2. Primary production by and standing crops of macrophytes (seaweeds and seagrasses)

3. Primary production by benthic microplants (i.e., benthic diatoms, etc.)

E. Evaluate detritus production and input into marine system

1. From macrophyta
2. From terrestrial run-off

F. Evaluate benthic bacterial biomass in soft sedimentary habitats

III. Examine and confirm most critical habitats susceptible to environmental perturbations

A. Impacts on these ecological subsystems (habitats) of man-induced perturbations

   1. Oil spills, effects and fate

   2. Continuous oil seepage from industrial operations, effects and fate

   3. Logging and rafting (storage)

   4. Increased urbanization

   5. Commercial fishing

   6. Recreational activities

   7. Cannery wastes and point source discharge

B. Impacts on these ecological subsystems of natural perturbations

   1. Storms

   2. Freshwater run-off

   3. Seismic disturbances

   4. Foraging habits of certain marine and terrestrial species

   5. Red tides and subsequent die-off

   6. Ice scour--shallow embayments and flats

DESIGN OF AN ECOSYSTEM STUDY OF PRINCE WILLIAM SOUND

Backup Information on Renewable Resources

The following information is extracted from the workshop transcript, and is arranged generally according to principal habitat types characterizing Prince William Sound. The format for discussion included the following main topics for each habitat type which, while sufficiently discrete in organization to be termed an ecological subhabitat of the total Prince William Sound ecosystem, when viewed in their totality interrelate to form the comprehensive Prince William Sound ecosystem. Moreover, the outline below represents a listing of priorities by the conferees to aid in preparing a comprehensive ecosystem study of Prince William Sound.

- Survey and cataloging existing knowledge
- Reconnaisance studies (including basic oceanographic parameters and background hydrocarbon survey)
- Identification of critical habitats (from viewpoint of man-induced environmental perturbations)
- Ecological processes driving the Prince William Sound ecosystem
    - Studies of ecosystems in principal Prince William Sound habitats
        - Riparian and terrestrial (including marine birds, forests and terrestrial mammals)
        - Wetlands and salt marshes
        - Intertidal zone
        - Subtidal zone
            - Shallow subtidal
            - Deep subtidal
        - Water column
- Physical and physiological effects and ultimate fate of specific man-induced pollutants in Prince William Sound.

While studies of so vast and complex an area must necessarily start with a physical and biological inventory, the conferees placed great stress on the dynamics of the ecosystem in an effort to learn how

the ecosystem actually functions, rather than to simply describe it in a static mode. Environmental perturbations of any type affect the functioning of a major part of such an ecosystem, and the ultimate fate or amelioration of such disturbances is more involved with "process" than with "status."

Realizing the impossibility of learning about how every living unit of an ecosystem functions, an effort was made to identify dominant or key species in each habitat type for intensive study, thus to learn the principal interactions and how energy enters the system and moves through its main constituents in the food web. In some cases key or index species could be readily identified; in many other instances the subsequent study must provide information on which to base such selection.

TERRESTRIAL ZONE (INCLUDING UPPER RIPARIAN)

Impact on the marine ecosystem by the terrestrial environment and changes within it are of special significance because the detritus carried into the marine environment by freshwater run-off is certain to be an important source of energy for marine organisms. It is surmised, e.g., that the suspension-feeders on the west side of Cook Inlet, a nearby ecosystem, are supplied chiefly from terrestrial systems rather than from the marine environment (D. Lees, 1977). Little or nothing is known about the marine detritus contribution from Prince William Sound forests, but since it is of sufficient significance elsewhere, it warrants special attention.

Timber sales and subsequent logging operations in Prince William Sound are anticipated to be comparatively slight according to USFS representatives at the workshop. Over a period of many years no more than 20 percent of the forested area would be affected. Because climax forests are comparatively sterile habitats, it is possible that clear-cutting would actually enhance plant growth and the subsequent production of increased detritus subject to run-off transport to streams entering Prince William Sound, making the marine habitats richer in food resources.

Fishery biologists of the Chugach National Forest, in cooperation with personnel from the Alaska Department of Fish and Game, are planning an inventory of all streams in Prince William Sound during the summer of 1978. Investigations will especially cover stream blockages (to homing salmon, fry and smolts) and future stream enhancement operations. On Montague Island during 1978, timber management studies will be conducted with specific attention given to soils, landscape disruption and stream pollution adverse to fish. Additionally, USFS and NMFS divers are examining underwater aspects of potential bargeloading embayments to rank those locations considered least deleterious to aquatic life. During the latter part of 1978 a timber sale scheduled in the St. Matthews Bay area near Port Gravina would make an ideal enterprise to facilitate study of the impact of logging on the adjacent renewable marine resources.

Both deer and land otters frequently forage in the marine environment. The former browse extensively on marine algae during the winter, and should clearcutting reduce part of their winter habitat, they may well depend even more on marine algae during heavy snow cover.

Land otters often enter the marine waters and forage like other marine predators. They have been observed frequently foraging in both intertidal and shallow subtidal areas of Prince William Sound on mussels and clams.

MARINE ENVIRONMENT

PLANT LIFE

A. Kelp and seagrass resources

Although kelps abound in Prince William Sound, the extent of harvestable kelp is unknown; for that matter the total Alaskan kelp resource is an unknown quantity. Distribution maps of Prince William Sound kelp resources are urgently needed. The importance of seaweed/seagrass to the Prince William Sound ecosystem needs evaluation. Shelter for juvenile stages, food for herbivores, spawning substrate and the reduction of dead and decaying kelp and seagrasses to enhance the detritus supply are all very important factors in sustaining the Prince William Sound ecosystem.

Because kelps and seagrasses are shallow water plants they are vulnerable to surface contaminants such as oil. The major physical effects of crude oil contamination include smothering, displacement and alteration of substrate. Nothing is known in Alaska about the renewal or recovery time for the seaweed/seagrass resource after a kill-off by an environmental disaster or after being harvested for commercial purposes. The latter use is imminent, for Alaskan kelps have been found to be as high in alginic acid concentration as kelps assayed from other American coastal areas and will be in demand when economically feasible to harvest.

The only commercial harvesting of kelps in Prince William Sound presently relates to the kelp/herring roe fishery which, while not extensive, is nonetheless potentially threatened by two man-induced conflicts. The historic herring spawning areas in the northeastern sector of Prince William Sound are adjacent to the tanker lane. The Alaska Department of Fish and Game has conducted a modest study of kelp/herring roe fishery for management purposes (Rosenthal, 1977). Village subsistence fishing on this resource appears to be low. An oil spill or extensive commercial harvesting operation are potential perturbations needing extensive evaluation.

B. Salt marsh plants

The heads of fiords and embayments in Prince William Sound frequently support extensive stands of salt marsh plants, and oftentimes sea-grasses occur along with them. Doubtless these "meadows" of Prince William Sound are important providers of detritus for bacterial growth and as food for suspension-feeders. Almost nothing is known about these stands, although it is thought that an EPA-funded project to be undertaken by Dr. Peter McRoy, University of Alaska, will be initiated somewhere in Prince William Sound. The salt marshes of Port Valdez and vicinity were studied by Crow (1977).

Because these plants occur at the upper ranges of the intertidal zone, they are especially susceptible to oil catastrophes. For ecosystem management purposes it is essential to evaluate their comparative importance in the system's energy flow, and to map locations of the most extensive stands.

C. Algal mats

At the head of virtually every embayment in Prince William Sound is a mudflat or a mixed mud and sandflat which supports a mat of microscopic algae (diatoms, etc.). While alive in the spring and summer, these algae provide food for benthic copepods and micro-larval forms of invertebrates which, in turn, are fed upon by salmon fry coming out of the streams. Pink and chum salmon fry appear to use these benthic copepods as their primary food during this critical period of their development.

Benthic diatoms forming algal mats are both intertidal and subtidal, as well as being a surface covering on nearly every substratum for a brief period during their spring bloom--the precise time salmon fry are starting to feed on the benthic microfauna. This linkage is being studied presently by University of Alaska biologists, especially with respect to the feeding and movements of pink salmon fry released from the hatchery at Port Nellie Juan. Additional effort should be placed on such studies, because the receptivity of the estuaries for salmon fry emerging from Prince William Sound streams may well be the most significant factor in Prince William Sound salmon survival.

Other studies at Port Valdez indicate a direct progression from the development of the algal mat to benthic copepods (the grazers on the mat) to salmon fry. Doubtless, oil spills would have immediate and deleterious impact on this segment of the ecosystem.

Spring and summer blooms of microscopic algae comprising the mats quickly give rise to detritus as fall approaches which then supplies an energy source for bacteria and microfauna. Little is known about

the contribution of the algal mat to the total energy production regime of the marine environment. Since it appears to be of real significance in Prince William Sound, it should receive attention in an overall Prince William Sound ecosystem study.

D. Phytoplankton

Aside from primary production studies undertaken by University of Alaska personnel as part of the Alyeska project at Port Valdez, Jack Bay, Valdez Narrows and a few other locations, the workshop review cited information which must be obtained to understand the dynamics of the Prince William Sound ecosystem. The Alyeska project studies were conducted mostly during winter and early spring, thus seasonal information on a year-round basis is lacking even at the previous study sites.

Traditional C-14 measurements or measurements of total chlorophyll present, while important, are not sufficient to understand how energy begins its flow through the system. It is often more important to know what genera or species of phytoplankton are being consumed by grazing copepods or larval forms, since phytoplankters are usually selectively taken as food. This approach to the study of phytoplankton will provide clues to the dynamics of the ecological process which a simple inventory could never provide.

Year-round studies should disclose chlorophyll maxima in relation to water stability and traditional oceanographic parameters. The relationship of these parameters to phytoplankton production and densities needs to be understood, as well as the distribution and patchiness of phytoplankton under varied weather conditions. Patchiness is of special importance to larval organisms depending upon phytoplankton for their sustenance during critical periods of their life history.

E. Bacteria

The role of bacteria in ecosystems, aside from the particularization of dead and decaying organic material, is just now being understood largely because of the introduction of new techniques for studying their productivity rate or action coefficient, rather than simply measuring the standing crops as commonly done heretofore.

Mudflats and soft-bottom shallows of Prince William Sound embayments are rich in detritus and, of course, detrital-feeding organisms. It is entirely probable that many zooplankters and benthic microfauna are feeding principally on bacteria living on the microplants or

detritus itself. The detritus and suspension-feeders on and within these soft bottoms are exceedingly important mid-level units in food chains leading to certain important fishes and probing marine birds which consume clams, polychaetes and other such associated organisms. Indeed, in one study of Cook Inlet (Lees, et. al., 1977) the detrital-feeding clam, *Macoma baltica*, showed a population decrease of 50 percent between April and July, the time of their peak utilization by shorebirds and diving ducks. At other times of the year little or no reduction in population occurred. Thus, elimination of these clams by any environmental perturbation would have serious impact on certain bird populations. And this clam/bird relationship is most likely basically driven by the energy clams derive from the bacterial population in the detritus.

Unlike rocky shores, the percolation qualities of the muddy or sandy substrates supporting extensive clam populations would be most significant in case of an oil spill. In the more permeable substrates where oil can move downward as the tide ebbs and upward as the tide becomes full, the persistence of oil in such bottoms will be long lasting and comparatively more devastating to organisms within them. In the harder packed, less permeable bottoms the oil will be flushed away more quickly, and the negative effects on the ecosystem would be substantially reduced. This circumstance needs critical study in Prince William Sound so as to identify those embayments which would be most adversely affected. Managing the disposition of derelict shipping oozing oil should be conditioned by such studies.

F. Freshwater run-off

Freshwater run-off into Prince William Sound has been alluded to above, but it should be singled out for special study because of its highly seasonal impact. For four months each year--spring and early summer--the run-off from melting snow is very heavy. Localized kill-off of marine plants and animals is apparently common in Prince William Sound. On the other hand, positive values of freshwater run-off are great with respect to the transport of detritus and nutrients from the land.

Special studies should include detrital and nutrient loads, sediment loads, and such deleterious impacts as localized kills of marine organisms and their repopulation.

ANIMAL LIFE

A. Zooplankton

More information exists for zooplankton in Prince William Sound than for phytoplankton. Ten stations were occupied by Seattle-

based researchers in October 1975. These studies, among other things, related zooplankton movements to the horizontal and vertical distribution of phytoplankton. Lacking still is information on seasonal population variations, diel vertical migrations, and how the seasonal cycle of zooplankton populations relates to the phytoplankton cycle. Key component species must be identified and followed through their seasonal variations to understand how the lower trophic levels in the ecosystem function.

Two of the major contributors to the biomass of Prince William Sound, the snow crab on the bottom and the mid-water pollock, have planktonic larval forms which comprise part of the zooplankton at one period of their life history, and concurrently depend in turn on other zooplankters for their food supply. Since zooplankton characteristically rises toward the surface at night followed by their predators, this portion of the ecosystem complex is susceptible to floating or shallow water contaminants and needs to be known rather thoroughly.

B. Macrofauna

Because animal species can best be considered in assemblages characteristic of major physical habitat types in Prince William Sound, the conferees first discussed and agreed that the following habitat types should be selected for study, with several key or dominant animal species in each identified for concentrated study so as to understand the dynamics of each subsystem. Each of these subsystems ultimately would be integrated with the others to formulate the overall process within the Prince William Sound ecosystem. Three vertical zones were selected--intertidal, shallow subtidal (to 30 meters), and deep subtidal (over 30 meters in depth). These were further subdivided according to the chief substrates found in each. The intertidal zone was divided into (a) protected heads of bays and fiords, which were appropriately further subdivided into mudflats, sandy beaches and saltwater lagoons; (b) rocky shores: (c) cobble and gravel shores; and (d) ocean entrances (unprotected rocky shores). Two distinct bottom types were recognized for each division of the subtidal zone; (a) soft sedimentary bottom; and (b) rocky bottom.

For clarity and emphasis the macrofauna are discussed in four natural groupings: invertebrates, fish, marine birds and marine mammals.

INVERTEBRATES

Intertidal Zone

Protected heads of fiords and bays

Presently scientists of the University of Alaska and the Alaska Department of Fish and Game are observing the effects of hydrocarbons on *M. baltica*, the most ubiquitous clam in the intertidal soft bottom areas of Prince William Sound, and thus a good index species for this habitat type. Such vital functions as filtering rates, respiration rate, etc., seem to be altered by the presence of hydrocarbons. Using a resistant species such as *M. baltica* rather than a weaker species, for these studies, has been deemed the wisest course to follow.

Most clams in the soft bottom of Prince William Sound are at the northern limit of their range, and thus can be considered to be under considerable stress even under normal conditions. Temperature fluctuations, e.g., are reflected in substantial population declines and increases. Some year classes appear to be completely missing, presumably due to adverse environmental conditions affecting some critical stage in their life history.

Clam species singled out for attention besides *M. baltica* are *Mya arenaria* (heavy muddy flats), littleneck clams or cockles in sandy-gravelly areas (*Protothaca*), and butter clams (*Saxidomus*) found on sandy-gravelly beaches. It was observed also that butter clams are an important food of sea otters.

Clams of the Galena Bay beaches have been the most intensively studied and published upon in Prince William Sound, although some information on clams in Port Valdez is available from the Alyeska Project and from subsistence fishermen. Adjacent to Prince William Sound near Cordova, considerable study by Alaska Department of Fish and Game scientists has been focused on the hard shell clams and razor clams (*Siliqua*).

It is estimated that the hardshell clam resource in Prince William Sound would support only one to three commercial fishermen. These clams are not overly abundant, and have a slow growth rate because of the cold water. Each small bay appears to have its own distinctive population dynamics. Currently there is a small commercial fishery in Prince William Sound for razor clams.

The 1964 earthquake, it is estimated, destroyed about 60 percent of the butter clam population in Prince William Sound. Now, 14 years later, very few locations appear to have had normal population levels return. Annual recruitment is sporadic, and pressures on the populations from natural predators, including sea otters, humans or environmental catastrophes can and do decimate the populations for many years. Population increase in the city of Valdez

has resulted in many more people taking hardshell clams in Galena Bay and Sawmill Bay. Much work needs to be done to evaluate the recurring impacts on these clam species as well as the impacts resulting from continued population growth and potential oil spills.

Rocky shores

Unquestionably, the most common species on rocky shores in Prince William Sound, and first in terms of biomass, is the blue mussel, *Mytilis edulis*. A very tolerant species, it is circumpolar in distribution. Comparative data are thus readily available on this species making it a superb index organism for concentrated study on the Prince William Sound ecosystem. Additionally, it is an important food source for fish, sea stars, dungeness crabs, birds (especially wintering scoters and the golden eye), and both sea and land otters.

Widespread distribution along Prince William Sound rocky shores, ability to withstand freezing and changes in salinity, and their easily visible and accessible location appear to make them an excellent species for detailed investigation. The only discordant fact is that their hardiness may reduce their serviceability as a weathervane for detecting sufficiently early a deteriorating ecosystem. Thus, in addition to *M. edulis*, an organism should be selected as an index species which is more sensitive to environmental fluctuations, yet has a high degree of reliability. Two such contrasting organisms important to the major energy flow through the ecosystem can thus function as checks and balances on the system. Important too is the capability of mussels to be bio-concentrators of contaminants which makes it possible, by appropriate analytical techniques, to detect environmental problems before other populations show evidence of deterioration--an "early warning system" as it were.

Reconnaissance surveys were conducted at a number of sites in Prince William Sound following the 1964 earthquake. Stoner Haven investigated the effects of land-level changes on intertidal invertebrates and William Johansen examined the effects of elevation changes on benthic algae at 33 shoreline stations in Prince William Sound (National Resource Council, 1971).

Previous investigations of the rocky intertidal habitat in Prince William Sound are scattered, but some have been carried out with some thoroughness. The Alyeska project supported an investigation of about 10 species of invertebrates, including the blue mussel, over a two-year period in Port Valdez. The most intensive part of this study concentrated on the blue mussel, and it will be reported in an M.S. thesis in late 1978 written by a University of Alaska student, Gretchen Kiser.

Some biological investigations have been carried out on rocky shores at the ocean entrance to Prince William Sound on Latouche Island and in Zaikuf Bay off Hinchinbrook Entrance (NMFS, Auke Bay). These studies, spanning three seasons of one year, dealt with a suite of "dominant" animals and plants. Biomass was estimated by species, and diversity indices were developed. No other studies of this kind are known to have been carried out in Prince William Sound.

At Port Valdez cursory monitoring work is being carried out by the National Marine Fisheries Service, and another baseline monitoring study on six or seven rocky shore areas sponsored by BP is being conducted by Eric Cowell based on methodology developed in Wales.

It is generally believed that the Prince William Sound fauna and flora is similar to that found from Washington through British Columbia to southeast Alaska, except that the species in Prince William Sound are at the northern limit of their ranges. Thus, a reasonably good basic knowledge of species/habitat distribution and their ecological relationships should already be known. Yet, the rocky intertidal area of Prince William Sound itself is still very poorly understood and merits great attention on the basis of its comparative importance to the total Prince William Sound ecosystem.

Subtidal Zone

Shallow water benthos (to -30 meters)

Information is exceedingly sparse about soft-bottom, subtidal communities in Prince William Sound. The assemblages comprising the coherent communities on various types of substrate are unknown, except for a smattering of descriptive work done in Sheep Bay. A recent paper by Ralph Pirtle, Alaska Department of Fish and Game, covers historical catch statistics for the commercial fisheries, both fish and shellfish, in Prince William Sound. Thus catch records are about the only data available for most of the subtidal region of Prince William Sound. Only recently has work begun on the biology of the snow crab in the Sound.

Conventional types of biological sampling gear are not well suited to the habitat under consideration, direct observations and the acquisition of data obtained while diving seems to be the best method available for these shallow areas.

The dungeness crab fishery is the best known, because a commercial fishery for this species took about 1.25 million pounds annually before the 1964 earthquake. Since 1964 the dungeness population has declined markedly, with the commercial annual catch today reduced to about 200,000 pounds. Subsistence fishing for these crabs has never been quantified, but it is intense in areas near the Valdez population center, in Valdez Arm, Galena Bay and Sawmill Bay.

Present study efforts on dungeness crabs by the Alaska Department of Fish and Game is but minimally funded. There is presently no information on the distribution of commercial-sized crabs, females, or sublegal-sized crabs. Inside Prince William Sound most commercial-sized crabs seem to be concentrated in Orca Bay, and the commercial fishing is located there. The basis for management is so rudimentary that conflicts between commercial fishermen, subsistence fishermen, sport fishermen and sea otters, while acknowledged, are ignored. Where there once was an important commercial fishery location between Hawkins and Hinchinbrook Islands on the inner side of the Sound, there now seems to be only sublegal-sized crabs despite the fact that there is no fishing pressure on this crab population.

One of the important patterns of shellfish movement--inshore, offshore migration--is almost totally unknown in Prince William Sound. During certain seasons the bottom less than 50 feet in depth is literally covered with juvenile snow and other crabs which would be very vulnerable to oil spills during their sojourn in shallow water. Juvenile dungeness crabs are seen commonly on the sandy and sand-mud type tidal flats during the summer.

Shrimp stocks are fished commercially on a sporadic basis. Draggers take some in the Elrington Passage, Columbia Bay and Whale Bay, and big spot shrimps support a small commercial operation at Port Wells. Two years ago, at Green Island, an enormous shrimp population developed and many schools of herring were attracted there to feed on them. They had never been observed there before and have not been there since.

The reasonably large populations of pandalid shrimps in Prince William Sound move upward from the substrate at night to feed on planktonic forms which also move toward the surface during darkness.

By day the plankters move downward to the bottom, as do the shrimps, where both feed on the benthos. Thus the shrimps are supported by two different sources of energy, one from organisms in the water column at night and one from the substrate during daylight hours.

Two other species of commercially important crabs occur in Prince William Sound. The snow or tanner crab is present in considerable quantity in virtually every bay, and represents a large portion of the biomass present. There is a great deal of information on snow crabs from other areas, but knowledge about those in Prince William Sound is nil. Otters take them for food, and juvenile snow crabs are known to be an important food source for the larger predatory bottomfishes.

The blue king crab is present at Port Wells, College Fiord and in Unakwik Inlet on the west side of Prince William Sound, and probably in many other locations as well. They are known to feed upon clams, hermit crabs and other benthic prey. Much more study on this species in Prince William Sound is needed.

Recently, the incidental catch of the snail *Neptunea* in snow crab pots indicates the potential of a small new fishery for the Japanese market. No data on this important member of the bottom community is available.

Octopus appear to be increasing in number, but nothing is known of their population size, fecundity, distribution and biological interactions in Prince William Sound. There is a potential fishery for this species, but this would depend on the gathering of much more information. From data gathered elsewhere, the octopus is known to be an effective predator on clams, snails and crabs. Its growth quickly to a large size in Prince William Sound indicates it plays an important role in the subtidal community.

The shallow subtidal zone also contains vast stretches of rocky bottom with its distinctive assemblage of plants and animals. Information on this habitat is extremely sketchy for Prince William Sound and only descriptive in nature. Most information available is from the east side of Prince William Sound, two sites on the west end of prince William Sound were studied for one year (Rosenthal, Lees and Rosenthal, 1977), in conjunction with NMFS, Auke Bay Laboratory with an emphasis on benthic marine plants and associated invertebrate fauna. NMFS has some information on Galena Bay and the vicinity of the oil terminal at Port Valdez.

A preliminary pilot project (Rosenthal, 1978) focusing on the inshore fish fauna was made recently in the northeastern Gulf of Alaska as part of the OCSEA Program. The study touched Prince William Sound only at the ocean entrances around Hinchinbrook Entrance and Montague Strait. The survey was conducted with scuba gear and depths to 100 feet were examined in both protected and unprotected habitat exposures. Information sought was an inventory of principal species, their vertical distribution, relative abundance and general food habits.

Protected seaweed beds and embayments were found to harbor a very diverse, yet seasonal fish fauna. Some were resident species such as Pacific tom cod and greenling. Others, i.e., salmon, etc., were just passing through into or out of Prince William Sound. The most stable populations were observed on the exposed outer rocky coasts. Typical species observed were the rock fishes--black rockfish, China rockfish, red snapper, Alaskan ronquil, lingcod, and greenling. Most were located around boulder fields just below the seaweed band.

During summer months the residents of the exposed seaweed beds were mostly greenling, Pacific tom cod and forage fish. Below the seaweed band was a different array of species--some were the large predatory types of current commercial importance which usually foraged along the bottom. Commercial species observed were halibut up to 200 pounds, red snapper up to 20 pounds and lingcod up to 50 pounds.

The commercial potential was evaluated at less than southeast Alaska, but nonetheless substantial. Many species observed were not hitherto known to occur north of southeast Alaska, yet appeared to be common in Prince William Sound. Thus, far more study is necessary to understand the nature of these populations and their role in the Prince William Sound ecosystem.

Previous to the OCSEAP pilot study mentioned above, NMFS had conducted trawling tests in Prince William Sound from 1954 to 1970, as well as some dragging for shrimp. Pollock was found to be the predominant near bottom species, along with turbot, tanner crabs and other benthic types. Pollock was considered to be present in Prince William Sound in commercial quantities. It was apparent from these tests that a potential conflict in interest would surely arise should the snow crab fishery and a pollock fishery both be developed in Prince William Sound.

Our current information of the bottom fauna in Prince William Sound is principally in the nature of an inventory--species lists, with a ranking of species based on guestimates of abundance. Nothing is known of vertical or horizontal distribution, the food and feeding habits or other ecological interactions. The timing of fish movements in and out of Prince William Sound are unknown, as is most information which could be classified as fisheries oceanography.

To add information for the Gulf of Alaska, an OCSEAP project for the summer of 1978 will make extensive dredge and trawl hauls at the ocean entrance areas of Prince William Sound to obtain information relating to the processes at work at the interface of the Prince William Sound ecosystem and the Gulf. The area to be studied will be between the Hinchinbrook Entrance and Point Whitshed, and as far west as Kayak Island. Several vessels will undertake pair-trawling, dragging, mid-water trawling, long-lining, pot-fishing and jigging to sample the species present and their distribution and abundance. Additionally, the NMFS vessel "Oregon" has recently completed bottom trawling and mid-water trawling within Prince William Sound.

A thorough stock assessment must be accomplished within Prince William Sound to determine the species of bottomfish and shellfish in commercial abundance on both sedimentary and rocky bottoms characteristic of such areas as the Knight Island Passage and Bainbridge Passage on the west side of Prince William Sound, where information is now a blank.

VERTEBRATES

Herring

Very little is known presently about the herring resource of Prince William Sound, although a herring reduction plant operated there from the late 1930s to World War II when it went out of business. Records indicate Prince William Sound produced 20,000 to 30,000 metric tons annually, whereas today's harvest is but 2,500 to 5,000 metric tons. Herring stocks seem to appear very abundant sporadically and then disappear for some years at a time.

The present fishery is comprised of sac-roe, kelp/roe, bait and food fish efforts. The sac-roe fishery now amounts to about 5,000 tons annually, but pressure is building to discontinue this type of use as being politically undesirable. Bait and food fisheries will doubtless be the most significant in the future. During the 1977-78 winter mid-water trawl fishermen took 140 tons of herring in Prince William Sound, the first time such a catch has been made. Herring are more difficult to catch in Prince William Sound for they do not congregate in bays where they would be accessible to seine boats as they are in southeast Alaska.

Many juvenile herring are present in Prince William Sound during the winter, but it is thought that these fish move out of the Sound and later return for spawning in the fall. It may be that there are two distinct stocks of herring in Prince William Sound--one a bay stock and the other an off-shore (Gulf) stock, with perhaps two distinctive spawning behaviors, one in shallow and one in deeper water.

Lack of information on which to base management decisions is critical. Shallow water spawners are extremely susceptible to environmental perturbations, and the shallow water spawning areas are in northeast Prince William Sound in the oil terminal and tanker channel areas. Information is available about where the major spawning areas are but they vary geographically from year to year. Juvenile herring characteristically concentrate near shore and comprise an important aspect of the nearshore ecosystem. They are thus totally vulnerable to oil spills.

Commercial fishermen state that the good bottomfishing, once present in Prince William Sound, dropped off dramatically when the herring reduction plant began operating. If this is true, herring obviously play an important role in the ecosystem process, but that role is not yet understood.

Conflicts abound with respect to herring in Prince William Sound, some human-induced, others natural. Predation on herring eggs is extensive by gulls and diving ducks. Large concentrations of

migrating waterfowl congregate in Prince William Sound in the herring spawning areas to feed on the eggs. Thus a large portion of all migrating waterfowl from Alaska may derive part of their sustenance at the expense of Prince William Sound herring. Marine mammals also concentrate when herring are spawning--sea lions, porpoises, killer and Minke whales. The extent of such predation, if it indeed takes place, is unknown.

An evident man-related conflict involves the kelp/roe resource and, of course, the adult fishery. The impact of the kelp/roe fishery is not known, but biologically speaking the number of eggs thus lost to the next generation of herring must have a minimal impact. Except for the observations of fishermen regarding the herring catch for the reduction plant, nothing is known about the impact of the herring fishery on Prince William Sound herring stocks. Information is urgently needed for purposes of wise management of the total ecosystem, not to mention the herring population itself. It is significant that in southeast Alaska herring reduction plants have not operated for 20 years, yet herring abundance was at low ebb until the past two years in which herring have been exceptionally abundant. These same fluctuations probably also occur in Prince William Sound, and may result more from variability in favorable food and other environmental conditions for juvenile herring than to the numbers of adults taken, eggs spawned or the extent of kelp/roe harvesting.

Salmon

Far more information is available for salmon in Prince William Sound than for any other important species subject to the commercial fishery, yet great gaps of significant information are still lacking. Pink salmon dominate the commercial fishery with the annual catch varying from about 3 to 6 million. Chums are second in abundance, averaging 400,000 to 2 million; and for sockeye about 150,000 to 200,000. About 500 salmon fishing vessels are involved each year in Prince William Sound about equally divided between seiners and gill-netters.

Pinks frequently feed extensively, mostly at the surface, after entering Prince William Sound, a circumstance probably related to less than optimum feeding conditions in the North Pacific. This feeding persists up to the time salmon enter the spawning streams, thus the ecosystem has an important impact on this salmon species.

Spawning areas in Prince William Sound are well-known, and up to 75 percent of the spawning is carried out in the intertidal area making the adults, the eggs, and the emerging fry usually susceptible to oil pollution. Moreover, laboratory experiments have demonstrated pink salmon eggs to be extremely susceptible to oil pollution at very low hydrocarbon levels, with most larval salmon

under these polluted conditions dying upon emergence from the egg. Juvenile salmon apparently detect hydrocarbon pollution at very low concentrations and definitely try to avoid it. Therefore, both oil spills and low level seepages in the terminal area will have deleterious effects on this important resource.

While intertidal spawning areas seem rather well known, very little information is on hand as to nursery areas, movements of fry, and the timing of such movements. The most concentrated study, now in its third season, is on the carrying capacities of Prince William Sound estuaries in the spawning grounds of pink salmon. This work, done by Dr. Ted Cooney and associates of the University of Alaska Sea Grant Program, has concentrated on Evans Island where they have studied the hydrological and planktonic aspects of the localities adjacent to the point of emergence of fry from the hatchery to areas where these fry move outward from the hatchery site. Concentrations and survival of fry have been related to the environmental conditions of the Prince William Sound waters, especially the presence of benthic copepods and other larval forms taken by salmon fry as food.

Information is still deficient with regard to the location of the fry at various other spawning areas of Prince William Sound, the time of residence in feeding areas and the time of movement of fry. Most of that available data is scattered in field notes or of a cursory nature.

Prince William Sound is an especially suitable area for aquaculture or salmon enhancement projects, especially for pinks, chums and cohos. Appropriate sites for aquacultural efforts have already been identified by Alaska Department of Fish and Game. Hopefully Native, federal and state land selections can be made to enhance the potentiality for aquacultural activities. To this end the USFS is now addressing the problems of conflicting land uses.

Marine mammals

The marine mammals of Prince William Sound are better known than any other group of animals through prior and on-going studies by Akaska Department of Fish and Game, NMFS, and U. S. Fish and Wildlife (A. Johnson). Sea otters and pinnipeds are best known, with much less information available on the larger cetacean species.

Gaps in knowledge are especially apparent with respect to total abundance of most marine mammal species in Prince William Sound, and insufficient knowledge is available with respect to seasonal changes in distribution, and about concentrated uses of certain areas seasonally from the ecological point of view.

The sea otter population of Prince William Sound is now at a rather high level, and their impact on certain substrates during foraging activities is quite disruptive of the populations of prey species. Their food habits are rather well understood in Prince William Sound, but no definitive information is available on the ranking in importance of the several prey species. Because sea otters remain on the surface except during feeding forays in the shallow subtidal area, they are especially susceptible to oil spills, a factor which must be considered when dealing with such catastrophes.

OCSEAP has supported some research on cetaceans in Prince William Sound by John Hall. Dealing with distribution primarily, some whales and porpoises were tagged but no follow-up has occurred because of lack of funding. Needed to understand the role of the cetaceans in the Prince William Sound ecosystem are more complete distributuion records by seasons and weather conditions, and food and feeding habits, especially with respect to the numerous smaller porpoises.

NMFS will undertake humpback whale studies in Prince William Sound during June and July 1978, especially in the Knight Island area. Tagging with radio-transmitters and subsequent continual monitoring of movements will be conducted by two vessels. The principal objective of the research will be to test methodology, but valuable distributional records should be obtained as well.

The Marine Mammal Act will greatly restrict food habit studies, leaving feeding observations about the only methodology available. Surface observations have revealed cetacean feeding on herring schools and sand lance, and killer whales have been seen taking salmon moving into Prince William Sound. Potential underwater observations by scuba divers or from submersibles will add much valuable information during intensive studies of the Sound.

Marine birds

Prince William Sound birds are known from previous survey studies which have been principally concerned with migrating birds. Two years of boat surveys and one year of aerial surveys have been conducted. Most of the work was concentrated in Port Valdez and along the tanker route; the rest of Prince William Sound has been rather neglected. In winter the surveys concentrated in Port Valdez and Valdez Arm. During summers studies concentrated on Hinchinbrook Island, with lesser efforts on Montague Island, Smith Island and Naked Island.

About 90 species were determined as dependent on the marine habitat in a variety of ways, from foragers on mudflats to pelagic feeders on forage fish, and to scavengers. However, vastly more work is required to learn detailed food habits to ascertain the role and

significance of marine birds in the marine ecosystems. Virtually nothing is known about seasonal changes in food habits or distribution. Except for some more comprehensive studies in Orca Inlet, no profound ecological data exist for Prince William Sound marine birds.

Those bird colonies resident in Prince William Sound are much better known ecologically than the very extensive migrating bird populations which utilize Prince William Sound intensively for brief periods each year. Food and feeding areas for the vast migrating flocks of waterfowl are certainly critical to the survival of the birds and must have tremendous impact on the Prince William Sound ecosystem. These relationships must be given high priority attention in the Prince William Sound ecosystem study.

As might be expected, many conflicts arise and potentially could arise between man and Prince William Sound birdlife. Motor boaters, helicopters, low-flying aircraft, tourist boats, etc., all have an adverse impact on marine birds. Frequently it is the scientists, themselves, who create much of the damage to bird colonies. Without critical bird colony sites being identified and widely publicized as areas to avoid as far as possible, even unsuspecting scientists traveling in helicopters, geologists surveying rock formations, etc., can easily disrupt bird colonies in a disastrous way should the contact occur during the breeding season. Regular visits to bird colonies at other than breeding periods by tourist boats do not create appreciable adverse impacts, because birds quickly become accustomed to such recurring alterations of their environment. Yet serious damage can be caused during nesting periods when disturbed birds can knock eggs or juvenile birds off their precarious perches.

Marine oil pollution is, of course, the most dangerous environmental perturbation marine birds can experience. Thus critical habitat identification and contingency plans for handling oil spills and damaged vessels is a very high priority for Prince William Sound. Widely disseminated maps showing critical habitats to avoid anytime or on a seasonal basis would assist the Prince William Sound ecosystem management process.

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WORKSHOP WRAP-UP

Raymond S. Hadley

Before I introduce Chris Carty to wrap this up for us, I'd like to thank all of you on behalf of the Alaska Sea Grant Program for participating in this conference. I personally enjoyed it very much and feel that it's quite successful. I've never been to a conference quite like this before where there is such broad participation and where everyone has said their piece and done it quite well. I'm rather happy to see this happen in Alaska. We're much too small to be divided into alien spheres, one from the other, and I like seeing us working together like this. Chris Carty, who is the Prince William Sound/MESA project coordinator, will wrap it all up and send us all home.

Chris Carty

I'm going to tell you as much as I know about "the MESA treasure chest" and make a few comments based on some of what's transpired here this morning.

I think MESA and the MESA approach to studies is a new thing in the government, but I think it's the way of the future. I joined MESA last year and we had three projects, now we have six. We are one of the few groups in the government which has been trying to do coordinated, holistic approach environmental studies. That gives me some optimism for our funding. We're getting increasing recognition as the people who've got the experience in the government to do this. I'm hoping that that's going to make the funding a little better.

As for the applicability of knowledge right away, in answer to some of Pat's comments, when Cmdr. Homer Purdy was here yesterday he was telling me that there have been some initial analyses of critical areas in the Sound, both with George Perkins of NMFS and in some of Alyeska's studies. Yesterday a fishing boat went aground, and he was trying to decide whether or not it was economically worthwhile to try to pump that oil off the ship or whether he should just leave it there. Economics is something Homer has to take into consideration. It turned out that because of some of these previous studies, he was aware that that area is a crab spawning area, and that at this time of year there are likely to be larvae present. The decision from Homer Purdy was, okay, we're going to go out there and we're going to try and get the oil off the ship. The project is practical, and there isn't going to be a huge time delay. We're going to be able to have more and more input as we go along.

As to funding. The funding process is that MESA makes a proposal, it has to be approved through NOAA, then is has to be approved through the Department of Commerce, then it has to go through the OMB, the Office of Management and Budget, then it goes to Congress. I think we're pretty good on the NOAA end. Commerce and OMB are the question marks.

As things stand now, the funding for this fiscal year, FY 1978 (fiscal years running from October to October), we have money from EPA, from Interagency Energy/Environment funds, which we were able to get right away and use to get this project started with right now.

For next year, fiscal year 1979, which starts this October, we are again anticipating some EPA energy related funding, plus MESA is going to divert some of its funding. We'll probably be able to double the effort for next year. The output from this meeting is also going to be used to work up our project development plan. If we can get our project development plan submitted, and go through the whole budgetary process this spring, that means it would be considered for funding as of October 1980.

We think we may have a simpler way to go. One of out other projects, the New York Bight Project, has been level funded. Congress has approved a level amount of funding throughout the period of the project's duration, and we've already peaked out on our maximum activity. We're starting to cut back. So all that cut-back is funds that are already allocated. We're going to try to get permission to reprogram some of that money into the Prince William Sound Project. We think it would be easier to get permission to reprogram than it will be to get a new line item in the budget from Congress. The way things look now is: fiscal year 1979, we've got a little bit of EPA/MESA money guaranteed; fiscal year 1980, we hope to get permission for some reprogramming; and fiscal year 1981, we plan to submit a line item in the federal budget.

What this means in terms of what will be going on in the Sound and what will be happening after this is that for the next few months there'll be an intensive effort to get this project development plan together. I've been recalled to my home office to do that.

Then the next thing we'll do with the money we know is coming for sure is the knowledge search, a literature search and an effort to tap the other resources that have been identified in this conference as being very important; all

the local knowledge and the industry and private studies that aren't generally in the data files of the big oceanographic data centers.

That is what's planned, and we will be getting into it as soon as this project development plan is done, which means we'll be getting started on it this summer.

After that we have to write up a technical development plan, which is based on the priorities that we've identified here and which will be outlined in the project development plan. We have to decide exactly what we need to do to get those objectives and goals accomplished. We'll probably do that by having a few much smaller conferences with some technical experts in marine science and some of the local people getting together and deciding what we need to know; how we find it out, and what's the best, most cost effective manner of doing it. That will be coming up within the next year or year and a half.

Because half of our funding for next year will be from EPA, and it is energy related funding, we think we will probably be initiating a very few research projects starting as early as October of this year. These will probably have to do with oil, and several of the studies that we've proposed are related to surface currents. If you read the Coast Pilot for the Prince William Sound area, it will tell you that the currents are weak and variable. When you figure the tremendous amount of stream flow and ice melt that happens in the summer, you know there's got to be some pretty fast surface currents, at least near where the rivers enter the Sound.

Another project that we identified and sent on to EPA was reconnaisance. I don't know what we called it. But I attended an oil spill/oil effects conference in Nova Scotia last fall where one of the conclusions was that one of the most important things in determining the effect of oil when it comes ashore in the intertidal zone is the type of intertidal zone, and the amount of energy being dissipated there. If it's a rocky intertidal zone and it gets a lot of surf splash and that sort of thing, the oil will disappear a lot quicker than if it's on a mud flat, where it will penetrate the sands, and then everytime you have a high tide some new oil will come seeping through. That can go on for years and years and years.

We think it will be very important to do some sort of reconnaisance survey where we can broadly classify the types of intertidal areas in the Sound, especially since the information will be useful for a number of different purposes.

What we'll be looking for in these initial projects are basic studies that other studies depend upon and studies that can be used in four or five or six different manners, because initially our funding is going to be very limited, especially by the standards of something like the Outer Continental Environmental Assessment Program.

I'd like to reiterate once more that we are not a regulatory agency. We don't only provide information to EPA and the Coast Guard; we also provide that same information to developers. We try to predict the effects of alternative activities. We don't say, do this over that, we say, if you do this, these are your probable effects, and if you do this other thing, these other effects will probably happen, and it's your decision.

I'm hoping that we will have a project office established here no later than this fall, but that's still a point of contention in the home office. So I can't really say anything more definitive on that. If we get reprogramming money for fiscal year 1980, which would be starting in October of 1979, next October, we would probably be putting out some requests for research proposals next summer. That would be the earliest that I can see us funding new research if we're successful in getting the money reprogrammed into Prince William Sound. MESA's first priority is to take the New York Bight money and put it into Prince William Sound rather than the other areas. That is our own internal priority, and we're going to see how far we can get that through the system.

I think that's all I've got. If there are any questions, I'd be glad to try to answer them. Otherwise, I really want to thank you folks, too, because as the person who is going to be involved in this literature search, you've greatly simplified my next task already. I got an awful lot more information in that respect than I had anticipated and it's going to help me out quite a bit. I've been able to identify quite a few of the people who have quite a lot of the information.

I'm very pleased; after having been to the Sound, I've become convinced that we really want to have a study there, and I think we've got a good chance; I think this meeting is really going to help it along. I want to thank you all once again.

APPENDIX A

Planning Meeting List of Attendees

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John Williams - Legislative Affairs Agency
John Goering - University of Alaska
Ernst W. Mueller - Alaska Department of Environmental Conservation
Wallace H. Noerenberg - Fishery Consultant - Prince William Sound Aquaculture Corp.
Fred Thorsteinson - National Marine Fisheries Service
Ted Merrell - NMFS Auke Bay Fisheries Lab.
Chris Carty - MESA
Herb Bruce - NOAA/Outer Continental Shelf Environmental Assessment Program
Stephanie Pollock - Alaska Department of Fish and Game
Dick Logan - Alaska Department of Fish and Game
Alan Meiners - Alaska Department of Natural Resources
Veronica Clark - Alaska Department of Community & Regional Affairs
Cathy Carssow - Alaska Department of Natural Resources
Albert Collotzi - U.S. Forest Service
Shari Gross - United Fishermen of Alaska
Craig Wiese - University of Alaska
Brenda Melteff - University of Alaska

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APPENDIX C

AGENDA

MESA Workshop on

Prince William Sound

Tuesday, March 7, 1978

9:00 a.m.	Registration
9:15 a.m.	Welcome Ray Hadley, Alaska Sea Grant Program
9:20 a.m.	Introduction Frank Hebard, Director, Marine Ecosystems Analysis Program Chris Carty, Acting Project Manager, PWS Project
	SUMMARY PRESENTATIONS
10:00 a.m.	Fisheries Robert McLean, Special Projects Office, ADF&G
10:15 a.m.	Marine Plants Richard J. Rosenthal - Homer
10:30 a.m.	Marine Mammals Kenneth Pitcher - ADF&G Anchorage
10:45 a.m.	Marine Birds Pete Isleib - Cordova
11:00 a.m.	*Coffee break*
11:15 a.m.	Forest Products Clay Beal - U.S. Forest Service Anchorage
11:30 a.m.	Water Robert Carlson, Inst. of Water Resources, U. of A.
11:45 a.m.	Oil, Gas and Other Minerals J. Robert Moore, Inst. of Marine Science, U. of A.
12:00 noon	*Lunch*
1:30 p.m.	Tourism, Recreation and Boating, Scenic and Wilderness Neil Johanssen, Div. of Parks Anchorage
1:45 p.m.	Heritage, Waste Disposal, Power-utilities, Land Use Glenn Akins, Department of Environmental Conservation
2:00 p.m.	Transportation Chris Low, Department of Transportation Juneau

WORKSHOPS

2:15 p.m. Description of workshops, what is expected as output
Ray Hadley, Alaska Sea Grant Program

2:30 - 5:00 p.m. Renewable Resources, Nonrenewable Resources, Recreation, Urbanization

Coffee will be available at 3:00 p.m.

Wednesday, March 8, 1978

WORKSHOPS

9:00 - 5:00 p.m. Workshops continued

Coffee will be available at 10:30 a.m. and 3:00 p.m.

Thursday, March 9, 1978

9:00 a.m. Introduction of Workshop Discussion Leaders' Presentations

9:15 a.m. Renewable Resources

9:45 a.m. Nonrenewable Resources

10:15 a.m. Recreation

10:45 a.m. *Coffee break*

11:00 a.m. Urbanization

11:30 a.m. *Adjourn*

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APPENDIX E

WRITTEN COMMENTS

URBAN-INDUSTRIAL DEVELOPMENT

AND

THE PRINCE WILLIAM SOUND ESTUARY

With the coming of the industrial revolution, urban centers have located and grown on the shores of some of the largest and most biologically productive estuaries in the world (London, New York, Tokyo, Hamburg, Seattle, Baltimore). It is at this urban-estuary interface that society has its most direct contact and most severe impact on the marine environment. The need for responsive management decisions based on reliable scientific information is recognized. Unique in its isolation from rapid industrial growth, Prince William Sound provides an unusual opportunity for pre-industrial scientific investigations and effective environmental management.

Prince William Sound is a complex fjord-type estuarine system bordering the northern Gulf of Alaska (Fig. 1). Lying under the arc of the Chugach and Kenai Mountains, the Sound is bounded on the east by the Copper River and on the west by the Kenai Peninsula (145°37' to 148°43'W, 59°46' to 61°16'N). Surrounded by several outward-radiating fjords, the Sound connects with the Gulf via Hinchinbrook Entrance and Montague Strait with limited access through the archipelagic islands at the east and west (Fig. 2). Prince William Sound is 92 km in lateral and 56 km in longitudinal dimension, covers 8,835 km^2 (Schmidt, 1977) and has a total coastline in excess of 3200 km (Grant and Higgins, 1910). Most of the shore line is mountainous, resulting in a restricted drainage basin. The climate is maritime, with moderate temperatures and heavy precipitation.

The Sound was originally inhabited by eight tribes of the Chugach Eskimo or cuatit as they called themselves, who lived by subsistence hunting and fishing (de Laguna, 1956). As early as 1740, Bering sailed along the Alaska coast making contact with the Chugach on Kayak Island (Golder, 1968). In the summer of 1778, Captain James Cook sailed into the Sound and named it after the son of Britain's King George the Third (Beaglehole, 1967). Further exploration by the Spanish, particularly Salvador Fidalgo, took place during the late 1700's (Grant and Higgins, 1910). In addition, Vancouver prepared charts of the region during this time (Hulley, 1953).

Aside from several short lived economic booms, Prince William Sound has seen little change during the past 200 years. Russian "promyshleniki" or professional hunters and fur traders (McCracken, 1957) harvested sea otters to near extinction during the late 1700's and 1800's. Copper mining thrived during the early 1900's until the rich veins were depleted. Prior to World War II, large scale fox breeding for the fashion industry was practiced on islands throughout the Sound (Hulley, 1953). Some reconstruction and research followed the devastation of the 1964 earthquake. Commercial fishing has been the only enterprise to flourish continuously during this time. The original native population of about 1,500 was reduced to less than 500 by smallpox during the late 1830's (Hulley, 1953) and the present population numbers less than 5,000, most of whom reside in Valdez, Cordova, Whittier and Tatitlek. Prince William Sound now serves as the receiving-loading area for the trans-Alaska oil pipeline. It is also experiencing growing recreational and urban stresses from

Anchorage and increasing pressure from commercial fishing.

Society imposes a multiplicity of uses and abuses on the estuarine environment. We use the estuarine system to assimilate our industrial and domestic wastes; as inter-urban transportation corridors; for commercial fishing; for wide ranging recreational activities; and simply as wilderness preserves. In dealing with these needs and wants of our society, planners and managers are finding it necessary to interact closely with the scientific community. This type of interaction in the industrial northeast, for example, leads Schubel to comment:

> Managers and planners rarely have the scientific expertise required for the formulation of plans for effective environmental management, and scientists have been derelict in translating the results of their investigations into a form readily usable by managers and planners. As a result planners have been disillusioned with academics and have turned to consultants for guidence. The typical planning documents that have resulted are of little value. They form a seemingly endless series of studies outlining the studies that need to be done, but they are of little consequence in affecting solutions. [1]

There is clearly a need to improve our approach to estuarine management. Perhaps, this is the time and place to attempt it !

G. M. Schmidt

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[1] Schubel, J.R., "Zoning, A Rational Approach to Estuarine Rehabilitation and Management". Special Report 1, Reference R75-4, Marine Science Research Center, State University of New York, 2.

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Schubel, J. R. 1975. "Zoning, a rational approach to estuarine rehabilitation and management". Special Report 1, Reference R75-4, Marine Science Research Center, State University of New York.

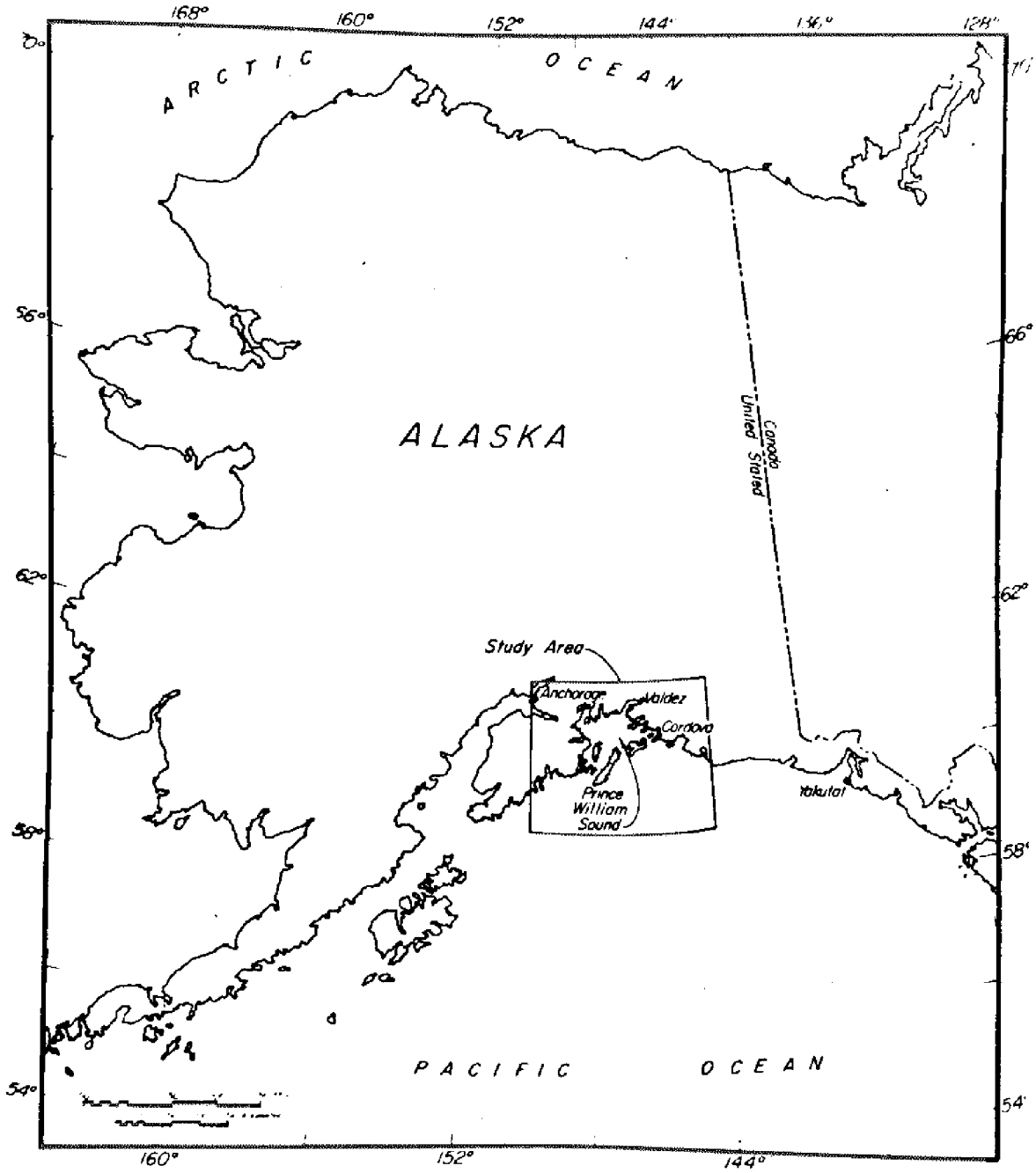

Figure 1. Geographical location of the Prince William Sound region.

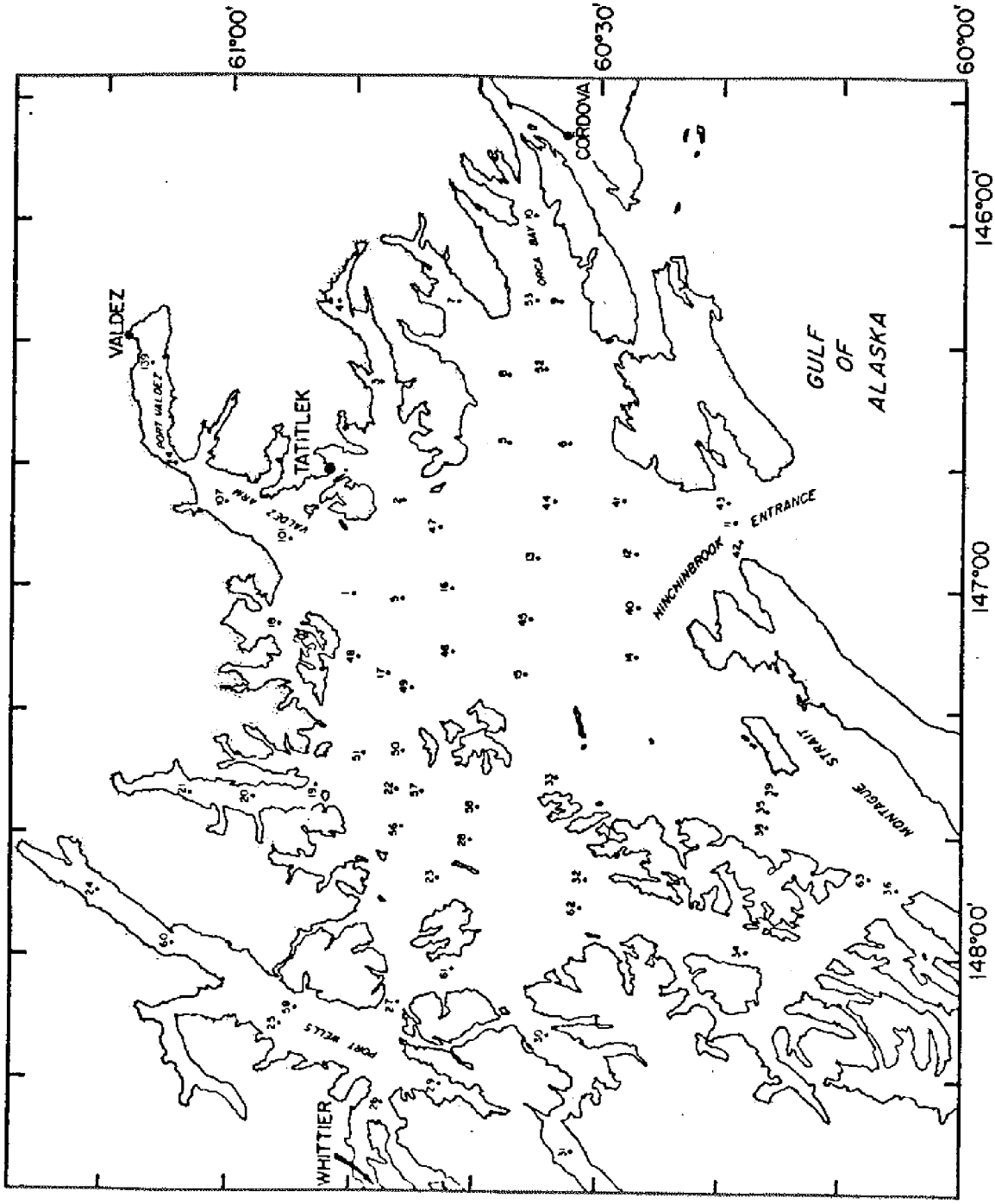

Figure 2. **Prince William Sound region.**