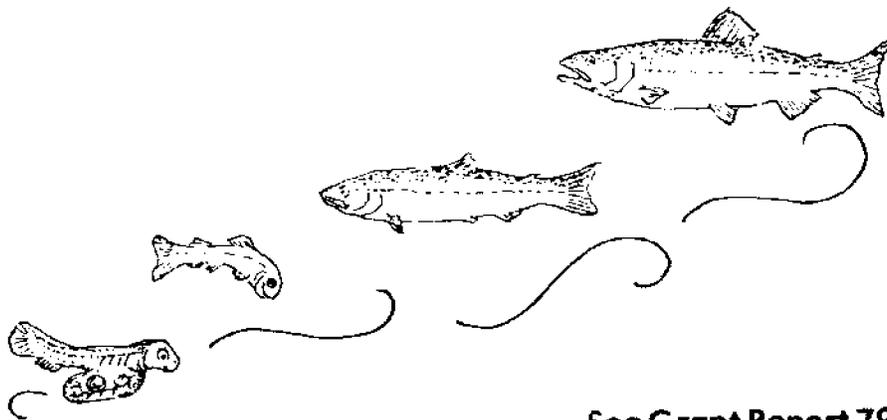




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Proceedings
of the
Workshop on
Estuarine Survival
of Salmon

Juneau, Alaska
February 8, 1979



Sea Grant Report 79-10
October 1979

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Alaska Sea Grant Program
University of Alaska
Fairbanks, Alaska 99701

PROCEEDINGS OF THE WORKSHOP ON THE
ESTUARINE SURVIVAL OF SALMON

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Compiled by

Raymond S. Hadley

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INTRODUCTION

In order to determine the present status of research in Alaska and to focus and coordinate future research on the problems of estuarine survival of salmon fry, a workshop was conducted under the auspices of the Alaska Sea Grant Program in conjunction with the annual meeting of the American Fisheries Society, Western Division, Alaska Chapter.

This workshop was convened on February 8, 1979, at the Baranof Hotel, Juneau, Alaska. Participants were invited from all identified research and user groups in Alaska currently participating in or intending to participate in salmon research.

The following invited participants formed a panel for the purpose of discussing the topic. The audience, composed of interested observers and active researchers and users, was invited to participate in the open discussion. This volume records the ensuing discussion.

PANEL MEMBERS

R. S. Hadley, Chairman	Alaska Sea Grant Program, University of Alaska
R. T. Cooney	Institute of Marine Science, University of Alaska
J. Bailey	Auke Bay Laboratory, National Marine Fisheries Service
W. Heard	Auke Bay Laboratory, National Marine Fisheries Service
D. Poon	Northern Southeastern Aquaculture Corporation
D. Lund	Sheldon Jackson College
R. Burkett	FRED Division, Alaska Department of Fish and Game
K. Leon	FRED Division, Alaska Department of Fish and Game
G. Freitag	FRED Division, Alaska Department of Fish and Game

Ray Hadley

For a number of years, people have realized that the next step in increasing salmon stocks, as far as research goes, is probably going to be in the estuarine environment. A number of proposals from various sources have been submitted to various funding agencies, and all too many of them have recently gone unfunded. So we thought we should get those people within the state who have an interest in this aspect of salmon biology together and to essentially sit around a common table and to an extent "BS." Frequently when proposals are submitted to Sea Grant, we have gotten such comments as "Gee, we didn't think that this was a problem." Or, "How much support are you going to get from NMFS?" Or, "Are they doing the same project?" Out of ignorance of what's been going on, we haven't been able to answer those questions well enough. We hope that meetings like this will help us to do that.

We would like to start off with a very short, informal presentation from our invited participants on what their agency or institution has been doing in estuarine survival of fry. I want to keep this short because we don't want this to be a rehash of what's already been done. What we want to do is jump from that into a real open session, audience as well as participants, on what might we do in the future, paying particular attention to questions such as: Is it possible to do some of these things? Is it cost effective to do some of these things? How can we work together to accomplish things that maybe none of us could do individually? So to that end, I'd like to start off by asking the participants to represent their institutions with an opening statement and then get right into that second phase as fast as possible. Ted, could you start off for us? From the University of Alaska, Ted Cooney.

Ted Cooney

I will speak for the Institute of Marine Science this afternoon. I believe that Will Barber will be here later to talk about programs in the Division of Life Science. Our expertise in Marine Sciences is really in the oceanography and fisheries oceanography area. For those of you who weren't here this morning when I described some of the work that we have done in terms of salmon fry survival problems, I'll just briefly say that our experience in the past three years has been on the subject of food web and habitat dependencies for pink and chum salmon fry released from the hatchery at Prince William Sound. This was a very site-specific study and our major interests there were examining the timing of events in the nearshore nursery areas as they affected the coupling of fry to their food. These are small-scale intensive studies of sorts that generate master theses and which can be handled by relatively small field parties living on site. I would guess that in the future we would attempt to follow this study up and perhaps others of this sort.

As far as goals are concerned, in terms of the Institute of Marine Science and its possible participation in the solution of some of the problems that we may discuss here today, we're very much interested in continuing what we would call comparative food web studies. We're looking at pink and chum salmon now in Prince William Sound and we do see a partitioning of the resources there between these two species. It's not so much that our information lends itself to recommendations, but really from the science side, we just hope to unravel the why's and wherefore's of some of these relationships that we've begun to see. As far as competition in these nursery areas is concerned, we've also noticed that the young salmon moved into these areas early as the release from the hatchery occurred. But as the fish began to move out in late spring and early summer into slightly deeper water, the nursery area began to fill with other species. We found the Sebastoides there; tomcod, sandlances, juvenile species of many kinds would move in, sometimes actually competing with the salmon in these nursery areas. That may be an important thing to look at again. This is the kind of thing that lends itself to a Master's or Doctoral thesis work.

We're very much interested in the overall problem of nearshore estuarine productivity. We're interested from the point of view in oceanography of the general subject area of organic matter synthesis and transfer in at least two or three steps of the food web. What we'd like to know is, what are the production cycles in the various estuarine and coastal systems that we run into in Alaska? And how does the timing and distribution of organic matter that is synthesized in these systems affect the survival of organisms in higher trophic levels, in which the salmon happen to be one of those organisms?

And lastly, we're just beginning to look at this general problem of oceanic and climatic variations in the North Pacific versus the survival of the species that fall into commercial categories of which there are records which constitute landings. So we're trying now to piece together some very descriptive information on long-term variations in weather in the North Pacific, specifically to address a study at Kodiak which is looking at the shrimp distribution and abundance, but more generally to apply it to a problem of high seas salmon survival. Joe Niebauer is doing the weather and sea-surface interaction work and the public record will probably supply the additional information as far as correlating that with returns of salmon species. We thought initially we'd like to look at pink salmon because they only spend one year at sea and it's not like trying to pull out a story for a species that spends one or two years in the ocean. I think, Ray, that's essentially about it from me.

Ray Hadley Next, I'd like to go to our NMFS (National Marine Fisheries Service) people, Dr. Jack Bailey and Bill Heard, for their input on this phase of the session.

Jack Bailey I don't see Bill Heard here, so I'll take it. I'll speak for what we are calling the Salmon CURVES Program at the Auke Bay Laboratory. CURVES is an acronym for Causes Underlying Variations in Recruitment in Marine Ecosystems -- recruitment of juvenile and larval fishes. There is an overall laboratory program in which herring, pollack, and pink and chum salmon are the target species. The program that I will speak of deals with the pink and chum salmon part of CURVES. We see the need for this activity because of the imminent growth of salmon aquaculture and the potential for some impact on juvenile and larval fish nursery areas or the ecosystem that they use. We have a background in the aquaculture field, and we have a research station that is turning out fairly large numbers of pink salmon fry which gives us a year-to-year assessment of marine survival of one of the target species. So we're going to base a lot of our initial work in the Auke Bay area -- between there and the Gulf of Alaska.

We want to study what the impact is going to be of introductions of large numbers of salmon fry into nursery areas, and to do this, we first have to define what a nursery area is. This morning, we heard Ted Cooney describe the concept of a nursery area, and it happens to fit in quite well with what we saw in the Trader's Cove studies several years ago. Our first hypothesis to evaluate, then, is our concept of a nursery area as an area of shoreline topography that induces mixing of deep and surface waters and also has some shelter in the lee of some of these physical features. We're going to do a lot of plain shoreline surveys to estimate the abundance of fry in controlled areas and in what we call our nursery areas to test this hypothetical nursery area description. Once we are confident that we know how to define nursery areas, then we can go on with some of the other aspects of the study.

One of the major needs that we see right now is some kind of a real-time input of environmental data for use by hatchery managers who are interested in timing the releases of fry from the hatcheries. There are studies in Auke Bay at the experimental hatcheries at Auke Creek that have shown some dramatic differences in the survival of fry, based on timing differences on the order of a week to six weeks. This means that if you really knew what you were doing and had some reason for programming your releases and uses of short-term holding, you could get something on the order of two-fold to eight-fold differences in marine survival of those fry, just by timing. That's the implication of what we have seen. So if we had the real-time data on what's going on in the nursery areas and knew what conditions in

these nursery areas are affecting marine survival to that extent, it is possible that something could be done about managing the timing of releases -- fine tuning right at the spring release period -- to maximize returns of the hatchery fish. And if it's that important to survival of hatchery fish, the same information must be equally important to the survival of naturally spawned fry that would use these and similar nursery sites.

If we have our finger on the pulse of what's going on there, the information obviously would be directly useful to people like those out at Kingsbury who are trying to put environmental data into their forecast equations and get a greater reliability on their forecast, get more meaningful information into those regression equations. If we are successful in our concept of nursery areas and identify what's going on there, we'll probably institute some annual year-to-year monitoring programs which would be of interest to the forecasters and the hatchery managers. I think that's about all I want to say right now. Many more details will probably come out during the session later.

Ray Hadley Thank you, Dr. Bailey. Dennis? Dennis Lund is from Sheldon Jackson.

Dennis Lund I'm not sure just which aspect of fisheries I represent here. I would think probably the one that comes closest to this discussion would be as a private hatchery operator. As most of you probably know, Sheldon Jackson College has one of the few non-regional or independent, private hatchery permits in the state. We've been in operation for three years now. Our primary function at Sheldon Jackson isn't research, it's teaching -- producing trained aquaculture technicians for the various hatcheries, both private and government. Another reason for doing research activities with regard to estuarine survival of fry is purely economic. We would like to increase our income as much as possible from the hatchery because the ultimate function of the hatchery that we built was not simply to train students, but also to provide enough income on a fairly regular basis to pay for both the academic part of the program and for the hatchery operation -- to make the whole thing self-sustaining.

As Jack Bailey indicated, we have tremendous fluctuations in survival. To give an example in terms that at this particular time means most to us -- dollars: With approximately the same number of fry from the same kind of incubation system, released at the same site, we realized a "nonprofit" of \$100,000 in 1975 and then one year later we made only \$1,400. So you can see quite a difference right there. Still another function would be, where possible, to have research that would contribute to the data base in Alaska, because we have an outer coast site right there handy, and we have a certain amount of help, including

some inexpensive labor, as a matter of fact, among the students. In fact, they're paying us, if you want to know the truth.

Research isn't specifically funded by the school; it's sort of done on a time and money available basis. As the hatchery production phases with the curriculum development and education and so on, and the income from the hatchery stabilizes, we hope that the school will be able to go into research in a more direct fashion. But as I say, right now we're kind of stuck in a funding pinch and we'll just have to let the fish pay for research in the future. We hope at the hatchery to stabilize production at 10 million pink and 10 million chum annually. Then when we reach the stable production level, instead of increasing every year as we're trying to do now, we hope that the data will be more consistent because we'll be putting the same number of grazers out there in the environment every year and we can log the return as they come back.

The data we've taken so far, as I say, has been done pretty much on a catch-as-catch-can basis. But we have been monitoring, of course, the out-migration timing of the hatchery fry from our incubators. We also monitor the out-migration of fry from Indian River, which is the hatchery stream, and compare that with the fish that come out of the incubators. As some of you may know, it seems to be fairly typical for the stream fish to migrate out a week or two later than the hatchery fish do. We would like to start plankton sampling with some guidance from the University of Alaska and National Marine Fisheries Service and help out where we can with our data accumulation. It would be very convenient for us to do because we're in town and we have student help and we already have some of the equipment. Again, unless we flat run out of money, we also will conduct some pretty extensive fin marking every year. This is partially for research purposes to help us refine our hatchery technique, and also for something you may not have thought of. Fin marking is important to private hatcheries for political purposes, because when you harvest 100,000 fish in front of your hatchery, the first thing many fishermen say is that those fish wandered in from somewhere else. So in self defense you must fin-mark fish. For the next two or three years, we probably will mark more than one group. Of course, we have to get the appropriate permission to do these various things, but the grouping we will probably use will be the early, middle and late out-migrant fry so that we have a group of fry from each part of the fish that we turn loose. Last year we had fry migrating out from the last week in January until the 5th of May, so we had quite a spread. We marked 100,000 fry and we hope to mark about that many every year with fin marks. For example, we marked the early out-migrants and then the late migrants (these were all unfed), and then the middle group of out-migrants.

We marked one group that was released right at the hatchery stream the way we released all the other fish. We marked another group that was taken a half mile away to a nearby island and released there so we could get a handle on the effect of near-hatchery predation.

I don't have the appropriate time for it, but I'd like to say that from the private hatchery viewpoint -- at least our private hatchery viewpoint, I see many needs with regard to pink and chum salmon production. The four most pressing are exactly what we're here to talk about, in large part the effect of estuarine conditions with regard to when we release our fry. We would like advice or would like to come up with our own data on the appropriate time to release the fry. Another thing we would like to find out about, which may or may not be considered directly related to estuarine conditions, is what small differences in fry size or fry quality are caused by different rearing or incubation environments and what effect those variations in fry size or fry quality have on ocean survival. All of us have a tendency to stock incubators heavier and heavier and heavier to try to get more production out of so many square feet of building space or whatever. And we say, well, gee, the fry looked real good when they went out, and they were only 10 percent smaller than the ones we turned out 10 per square inch on the gravel. But as we mark these fish and turn them loose, we really don't know if we're succeeding or not by trying to increase production in that way.

Another thing that I think everyone kind of accepted as a wise thing to do at one time (but it sounds like people are not now quite as sure about) is the short-term rearing of pink and chum salmon. This is in regard to being able to delay out-migration timing should we come up with some factor or indicator of when we should turn these fish loose. Well, if that indicator isn't present and the fry want to migrate out, obviously we have to hold them back. I'm not convinced as yet that we can be successful at the short-term rearing of pink salmon -- possibly the chum -- so I'd like to see more data on that. Central to almost all these things, I feel, is that something needs to be done to develop a marking method such as we have in the coded wire tag for the coho, so that we can mark large numbers of treatments. As it is now, maybe you have four treatments with a fin marking, so if you don't feed the fish so you can put oxytetracycline on the rear vertebrae or whatever, you've got four acceptable fin marks perhaps. And if you have hatcheries that are close together, some years you may not be allowed to use any of those. But right now we can only test one or two factors at a time and we have to wait a year before we can get any results back. So I would like to see some type of marking refinement, perhaps the coded water tagging system. That would help us a great deal because we could test many treatments at one time. That's about all I have to say.

Ray Hadley Next we have three people here from FRED Division, I think Gary was going to make the presentation. Gary Freitag.

Gary Freitag Yes, I think most of you probably heard my recovery effort talk earlier in the program here. We've got quite a bit of data out of that study, which was pretty extensive, and it indicated again that we do need to look at hatchery-release timing and things of this sort. One thing we're trying to do, of course, is optimize that return. We're producing a lot of fish and the more we can get back, the better hatcheries are in helping the environment and helping the rehabilitation of the fishery.

We have some data, for example, that indicates on this initial release we had at Beaver Falls in 1975, less than one percent of the fry came back. And of the fry that came back, the fed fish didn't seem to do as well. That is, again, different from what we're accustomed to, since some of the literature in the past has indicated that feeding does help fry survival. I have no doubt that this probably is the case, if the fry come back with equal chances as the unfed fry. Things we might consider as having caused something like that are, again, release timing, which is something we have to get a handle on. Another thing that I feel we should be looking at is the feeding behavior. Does pen-rearing a fish interfere with its feeding behavior when it's released? Has its behavior been altered? Are these fish as capable of avoiding predators as fish that are naturally coming out of the stream? So it's behavior studies that I think we're going to have to look at. Of course, in that initial release we may have had some differential mortality simply because the fed fish had a dual clip. They had a left ventral fin clip as well as the adipose, while unfed fish only had an adipose. This may have interfered with the way they swam, and given the predators something to home in on. As you know, predation is a selective type phenomenon. A predator will tend to select something that looks a little different. I'm not too sure that that was the cause in this particular release, but I think that we have to look at those kinds of things, such as adapting behavior of how the fish feed once they're released from a pen. Are they able to get enough food to eat? Are they able to adapt from the methodology we're using to regular feeding? I think that pen-rearing is something we're going to have to look at, as Dennis said. It seems to be something that is assumed pretty critical and there are studies that indicate, sure enough, that raising fish to a large size improves survival. That seems logical, but I think we have to look at what it does to behavior. If an unfed fish and a fed fish were released at the same time, I'm sure that the fed fish would probably do better. He'd be able to outswim and outfeed and avoid predation.

At present, there's not an estuarine study going on with the Department, other than that each individual hatchery tends to do some estuarine work as time allows. We're not budgeted for it but we really see the need for it. We've put together somewhat of a proposal in conjunction with the University of Alaska to do a little bit of work on this estuarine survival. However, we're still in limbo waiting for an idea of when we can actually get something like this under way when the funds become available. Release timing from the data that we have is indicated somewhat. We only have a few fish back that were coded wired type. But of those fish that came back, every one was a late-released fish, so we have a feeling that release timing on those tags is indicated. Next year, when the data comes in on our tag recovery effort, we'll have a better idea because we'll probably have on the order of thousands of tagged chum fry coming back and we should be able to identify whether late or early release made a difference. Again, this is somewhat of an estuarine study that we've conducted in the past, simply to look at this timing in the 1976 release. Some of the things that we put together with the University initially, which as I said are not funded right now, were studies on the physical conditions of the estuary. Many of the things that Ted and Dennis indicated on the estuarian conditions and stabilized physical environments for the fry. One of the big handles we want to get at, of course, is plankton concentration. Last spring when we made our first release, I did some initial looking at stomach contents and plankton tows and found very rapidly that the normal method most people are using in sampling the plankton doesn't represent what the fry are actually consuming. Of course, Ted's report this morning indicated that herpacticoid is a pretty important food source to the early chum. I noticed the same thing in the stomach contents. This is an important characteristic of the herpacticoids and you can't sample it effectively with a plankton net. So I think the methodology in sampling benthic organisms is needed to some extent. Ted was using a pump system, which I think is probably in the right direction, where we can at least try and get a sample of the benthic organism. The Canadians, I believe, are operating another system, which we'll talk about later on.

We also wanted to look at the behavior of fed fry and unfed fry and how or whether they eat the consumable items. "Habitat preference" is the way we listed what everybody else is probably calling a "nursery ground." This is an important characteristic.

We'd like to identify what nursery grounds are in the area of the hatchery. We did some limited studies last year on where the fry go once they're released out at Beaver Falls and Klawock. We know approximately where the natural chum fry go and, of course, at Beaver Falls we had the natural chum releases and we looked at that somewhat. So these are the kinds of things

that we're trying to look at and they parallel just about every other organization. Right now, as I said, we don't really have a formalized project, although we've gotten together and we've talked about putting together a pretty substantial program in the future. And I think that this meeting is probably a step in the right direction, where we can pool a lot of information and a lot of ideas on technique.

Ray Hadley Next, Derek Poon, from Northern Southeast Aquaculture Cooperation.

Derek Poon Thank you, Ray. I appreciate being here. I think the genesis of the idea of this particular meeting actually came out of an Aquaculture Policy Study Group meeting we had here in Juneau a couple of months ago. At that time, we had panel discussions on salmon research and development in the state. And Ray was there, along with NMFS and Fish and Game, and we were there. One of the real significant findings we came up with was the fact that we estimated only about one percent of the worth of the fishery was being put into research and development to sustain the fishery. And I remember Bill Heard saying that usually the industry percentage is around 10 or higher, particularly if you're talking about ITT or something like that. So I think that really puts the perspective on what we're doing here. If we've got that much of an industry going and we're only doing that much R & D, I think we're in trouble. So I certainly am thankful for the opportunity to participate in this panel. I think it will be very useful in pointing out some of the things we can do.

As a way of an introduction, I'd like to address the fishermen's interests in this particular topic; what our mission statement might be and how we might be involved in research. Then I'd like to talk a bit about current programs, limited as we might be, and future programs, and then I'll wrap up my 10 minutes.

To begin with, fishermen's interest is pretty obvious. They're the harvesters. We're interested in increased and stabilized harvest. Anything that would help us in obtaining that goal is going to be of interest to fishermen. Now there's a new twist. With the incorporation of this association, we are potential fish producers. All of a sudden we're interested in economics of investments. And that gets right back to ocean survival.

It's pretty interesting to note that the economics of salmon aquaculture in the Pacific Northwest are not exactly established. Very few studies look into the economics of everything. But there are some things happening of concern to us. For example, at Sheldon Jackson College in 1977 the return of 120,000 pink salmon, i.e., 8 returns per spawner in the Sitka area was a tremendously high survival rate and that was very fortunate. Then we turned around the next year, and the high survival

in the Sitka area did a twist. We had a return of only 1.4 per spawner. Very interestingly, on the inside of Baranof Island, it was showing 8 returns per spawner. Something happened in that return rate.

Just a little bit of information on the kind of variability we're looking at that has something to do with economics and investments: Weyerhaeuser's operation in Oregon coho return -- they've seen a 10 percent difference in back-to-back years in returns. And you try to make an economic calculation based on that. The Oregon chum program in Netarts Bay -- we don't have the marking program down there to really nail down the statistics in valid form, but the estimates right now are that the chum returns at Netarts Bay are well below one percent, probably half a percent if not lower. So these types of data tell us that there is a lot of variability going on out there and we're very interested in trying to minimize it. Otherwise, we put money in a project and we're going to end up not recovering very much.

From the point of view of the fishermen, we're interested in private as well as potential fish producers. Our mission statement, if you will, is that I think we'd like to see increases in stable harvest. And this is true not only in artificial harvests, which, as I said yesterday, are probably not going to be significant over the next 10 years relative to natural production in Alaska. So we're interested in both natural and artificial systems.

As far as research goes, we're interested in both basic and applied research. I think any basic research that addresses the distribution and abundance of salmon in time and space that will help us explain this variability is going to be great. You've heard quite a few talks here about that type of research. I think fishermen are probably of a more basic visceral type, who are more interested in applied research that can result in actual dollars in their pockets. This is going to be the key to any fisherman's interest in any activity that has to do with estuarine survival. They have to understand the exact benefits to them in dollar terms. It's really as basic as that. Our Association is not in a position to significantly fund any research program directly. However, I do see that the Association would certainly support any efforts to get agency grant money that would be directed at activities that the fishermen can really identify with. And I think that's the key. They have to understand why, or you can't get their interest up.

Now as for current programs; this will illustrate what the fishermen are interested in. Currently, we are not really into any programs per se because we haven't really gotten rolling as an association. But there's a tremendous interest expressed by the fishermen on predators and predator relationship-like studies that would directly result in some action programs that would

deal with predator control measures. I think they recognize that it has to be a well-designed program, but right now the interest in it is very high. As a result of this interest, we have contacted the National Marine Fisheries Service and the Alaska Department of Fish and Game, specifically on the CURVES program that Dr. Bailey and Steve Hoffman talked about on what they were doing in Tenakee Inlet. We would like to help those programs out in any way that we can because they are most directly related to what the fishermen consider to be action programs of interest to them. Without a lot of hard cash to deal with right now, we're trying to provide assistance by getting some labor help to them, in cooperation with Dennis's program here. We're trying to get some CETA technician help to these programs so that they can clear their sample processing. I understand that one of the limiting factors has been not having enough technician help. So our current emphasis is on helping programs of that nature and we're hoping that we can work this CETA thing out. With the current cut in money, we're not so positive.

As far as any future programs are concerned, I think aquaculture is going to need a pretty strong R & D arm. We're going to need the evaluation and we're going to need to know what type of information on limiting factors, not just estuarine. I can assure you that if we can make this understandable to the fishermen, then we certainly would try to support it. We would like to be able to tie in with agencies that would have the capability of conducting this type of study, and I'm hoping that it would be made in a formal type of understanding.

Just a very quick word on potential participation you might expect from the Association. I think first of all, we are a source of grass-root information that a lot of times is not even available to biologists. And I certainly have been very impressed with the kind of data that I've been getting from fishermen. They are a tremendous source of information which, if it is properly tapped, can be very useful to the scientific community. I think the Log Book Program is one example of something like this. So I hope that the agencies will feel free to tap it and open up communications lines. Also, I think you can find the fishermen a potential source of manpower for both sample and data collection. The key there is that first, you've got to have their interest, and second, it's got to be coordinated with their fishing season. We were talking about the potential for fishermen serving as sample collectors, and then discovering that during those times they were fishing for herring, or whatever, and somewhere else. But I think they are very willing to help. I've had standing offers from a number of fishermen on programs of interest. They're willing to go out, park their boats and do the work. I think I've taken my 10 minutes. Thank you, Ray.

Ray Hadley Derek mentioned predator-control studies and I know that something's happening at the Juneau campus of the U of A in that regard. Is there anything else, Chuck or Bill, that you can add to this? Background information? Chuck Meacham.

Chuck Meacham What I would say is that I think the project in Bristol Bay specifically indicated that predation can be very well qualified and that it can be very serious to production. All I would offer at this time is a procedure to look at it.

I think that the first thing you have to do is get a good hold on how many predators you have, whether they're birds, fish, or whatever. You have to make a population estimate. You also have to look at the count of the prey. In addition, you have to have some idea of the turnover rate. These things can be obtained. In Wood River we sampled char and counted the smolts in their stomachs. Then we captured Arctic char that had been feeding and held them. We sacrificed and sampled various ways, about 10 fish every 6 to 12 hours. Through time, we saw the prey being digested and came up with some digestion rates of prey for specific temperatures. As you would expect, we found that the rates were highly correlated with temperatures. So, indeed, we have the number of predators, the feeding rate, and the turnover. We put it all together and came up with estimates of predator effect. All I'll say here is that it can be done and it's very important to do it.

There is a report that's going to be coming out from the Alaska Department of Fish and Game as an information leaflet that has to do with the effects of confinement of Arctic char. That's the method that was used to decrease predation out there. I do have a couple of reports and memos that detail the program at Bristol Bay that's been under way for four years now that identify a little bit better what the program is.

Ray Hadley Earlier during the conference, Bill Heard and I sat down and had a conversation about some of the anomalies of returns he had witnessed. I'd just like to start this off with these questions and then just let it flow from you people who know so much more about it than I do: Is it possible that we could go back into historical data and, even with natural populations, make some correlations of these anomolous years with what we might know as environmental data or conditions of estuarine environment at that time? Or is the data lacking? If it is totally lacking, what's our first step in collecting it? I guess I'll throw that out, not just to Bill, but to anyone.

Bill Heard Actually, that's an excellent point from which to start discussing this sort of thing. To start some discussion on it, maybe I could add some comments to what Jack Bailey described about the Auke Bay Laboratory program that deals in these matters. The

program at the Auke Bay Laboratory is a laboratory-wide program. Salmon, of course, is only one component of that. In addition, this is an area that I have personally been involved with in my own work. The laboratory has an aquaculture component of its research effort, centered at two experimental facilities, Little Port Walter and Auke Creek. The primary purpose of both of these facilities is to do experimental work with cultured groups of fish to evaluate overall ocean survival. A difficult problem with using the term estuarine survival is sorting that out from ocean survival. I think they're two separate things and I think this is an important point and worthy of the title of your workshop, "Estuarine Survival." I'm not so sure how we're going to separate those -- but back to our aquaculture research involving the culture and release of juvenile salmon, and the evaluation of those releases in terms of overall ocean survival, which includes both estuarine and high seas, or total marine survival.

To my knowledge, Bob Parker's work on pink salmon about 10 or 15 years ago is the only measure we have of estuarine survival of salmon per se. We have measures of ocean survival and, from Parker's work and from intuitive feeling, we can just summarily state, in most cases, much of the overall mortality that occurs in the marine phase of the salmon's life is going to occur early on in that marine component of his life cycle. So, we've got a difficult set of things to deal with. Ted Cooney's approach this morning is certainly a valid approach in terms of looking at the estuarine environment. How we're going to correlate that in terms of historical information and contemporary hatchery information is a point that should be made. It's our philosophy in our NMFS aquaculture research work that we like to correlate and relate it to wild stocks of fish just as much as possible. This is one of the real benefits, in my opinion, of the aquaculture effort in the state of Alaska. It gives us a tool; it gives a handle to get measures of just this sort of thing. Maybe they're gross and crass, if you will, in terms of definitions between estuarine and open ocean. But still we're getting information from across the state from many different groups and agencies that we never had before. We're beginning to learn what we don't know, and I think that it's partly because we've been able to ask enough questions that you've assembled this workshop.

In our laboratory, Dr. Jerry Pella in our biometrics group has been doing some work along the lines that you mentioned on long-term climatic trends in looking at salmon survival and production data. It's not broken down in terms of estuarine survival over ocean survival. But he has identified what he perceives as some long-term climatic trends and changes that, in fact, are influencing current survival patterns. If you look at Southeastern Alaska you can see cyclic aspects of salmon

runs in any part of the state. Just in Southeastern, the pattern of pink salmon runs in the mid-1930s, with a period of perhaps five or six generations of pink salmon when we had 50 million or 60 million salmon caught, is totally different from what we have today. Dr. Pella has looked at those; he's looked at Bristol Bay. And there is some evidence that long-term cyclic changes are what we're dealing with in terms of what we see now.

I think we have to look at more than just one species. Dennis, I think, mentioned, or Derek mentioned coho. We've got to look at all species of salmon. I'm not sure how we do this, but a little later today I've got a couple of slides I'd like to show and make a point or two about some indirect evidence that ocean conditions which influence one species in one direction may be influencing another species of salmon in the opposite direction. I don't think we've appreciated that fully enough. We're working with different animals. Each species has a different biology, a different life history. We've got real complex problems, in terms of measuring estuarine survival. We can measure ocean survival and that's what we're starting to do with the aquaculture program. We've gotten at it a little bit with our assessment of wild populations, the work that's been done in the past. These data points are just gems. It's due to aquaculture that we're getting more now, and I think it's the kind of question that Dennis raised. From a practical standpoint, variations in survival, the examples he gave at Sheldon Jackson, are really what we want to measure. I don't think we can get at them except through some dedicated long-term commitments by the total research community of all the groups involved, in hopes that we can identify some of those procedures that we might start into down the road.

Ray Hadley

Maybe the question is, what approach can we take, with all of us having at various times experienced funding constraints? Are there any projects that would fill some of the knowledge gaps, that might not be initially long-term projects, which are obviously the hardest to fund? Are there gaps that we can fill next year or the year after that? Or behavior studies or better definitions of nursery areas that would be useful, that would get this whole thing off the ground and thereby make a better basis for going in for a long-term funding approach for major problems?

Ted Cooney

Well, I just jotted down some general classes of problems that came up as the talk went around the table, and it looks to me like just the sort of major categories that we're talking about here could fall under relatively few headings. We have a sort of general concern about nursery area characterizations, and that seems to involve temperature, salinity, food kinds, food supply, abundance, shelter, perhaps predator presence or absence, sort of site-specific in terms of the area that you're

looking at, with maybe some generalities coming out that would fall out of comparative studies from place to place. Then there seems to be a general sort of hatchery-related problem, with the idea of looking into the environment and trying to sort out signals that might be useful in determining what the timing would be to optimize the return on releases. And then it looks like the last category has to do with a much broader class of problems that relate weather and climate to the overall survival of salmon.

I'd like to expand a little bit on the comment that was made that we ought to have involvement of the scientific community. And my question is, time and again the University has proposed to do work in one or more of these areas, only to be criticized that we're playing a ball game that was essentially owned by somebody else. And I think the time has come when expertise around the state exists at several levels and in all sorts of units, and there must be some way of approaching this problem so that the players can integrate usefully and approach some of these problems. I have a really poor feeling for the political ramifications of digging around in someone else's so-called turf. But I think it ought to be a problem to explore as a part of this workshop, because I've had proposals turned down on the basis that I was looking at a salmon and the salmon was supposed to be someone else's job in Alaska and I'd better go back and work on sculpins or herring or something else.

So there's a very real problem that exists right now as to who does what, and it doesn't look like there's any shortage of the amount of work that needs to be done and it doesn't look like there's any shortage of expertise. It just looks like gluing it together has got to be done somehow, in a way that is unobtrusive and beneficial, rather than building barriers around various places in the ocean and saying, "OK, don't go in there because that's where the University of Alaska is doing their thing," and "Don't go in there because FRED's got that blocked out," and "Don't go over there because NMFS is doing their thing there." I mean, that seems like a very inefficient mechanism for dealing with these problems.

Now, I don't have any answers. I just know that the problem has arisen, and I view it from my end as one that has a tendency to exclude me, sometimes, from these kinds of operations. We get money from the state of Alaska as an institution for training students at graduate levels and introducing them to research projects, and yet we seem to have some trouble getting into the areas where we think we can make a significant contribution.

Floor

I'd like to take that one step further. There are a lot of us around the state who not only have trouble communicating amongst ourselves, but we don't understand how the University works,

how the Institute of Marine Science works; we don't know how the Division of Fisheries in Juneau works either. It seems to me you spend a lot of time putting proposals together and fighting for the same dollar. I guess my question to the University would be, it's difficult for us to work with the University when the University can't work with themselves. And it seems to me that there's so much interconflict right now, amongst your own people, that I just wonder how effective that is.

Fred Cooney

All right, I'm not sure that this is the place for the University to air its dirty laundry. But I will try to answer your questions about how the University does work, specifically, the Institute of Marine Science. It is funded primarily on competitive research grants through organizations that provide those kinds of grants. The National Science Foundation is one of the largest groups. EPA (Environmental Protection Agency) and other federal agencies, for the most part, fund most of the salaries of people who sit in the Institute of Marine Science. Very little state money goes into that group, and as a result, we're always working on proposals to keep ourselves funded.

The kinds of work that we address, the constraints that we have on our work, are such that we usually employ and utilize graduate students and technicians for a lot of the field-related work. For instance, FRED might say, well, what we'll do is take on one of your graduate students for the summer and he can come and work with us. And that sounds like a fine idea, and at the end of the summer he'll just write a report on what he did, and that'll be fine. So the student goes and works for FRED during the summer and does a salmon project or something. At the end of the summer, sure enough, FRED wants a report. Well, what we want from the student is a thesis, and that means that that student has independently collected some information. But the student comes back and rarely does he have a chance to shake the big bag right at the end of the summer because he's either got a few classes to finish up or there's some statistical analysis to be done. At any rate, there's a lag between the time the thesis comes out and the student's been in the field. So what FRED gets as a report at the end of the summer is not a student thesis, but rather some kind of a summary of what sort of work has been done there. And to some extent, we find that a little bit difficult to handle because oftentimes the supervisor of that student isn't involved in the research at all.

What we would rather see is some state support for some of these classes of problems that we talked about here, with the University sort of free from the political ramifications that sort of hamper the groups that are here that we're talking about and are very mission-oriented. They have their constraints and they

have to meet their deadlines. We, to some extent, don't fall into that. And I think that luxury allows us to bring to bear a little more intensity on some of the problems that may turn out to be a little esoteric, but on the other hand that may turn out to be practical. Whether or not that information can be picked up and used by hatchery managers usually isn't the business of the University of Alaska, but rather the information generation would be. Here's the environmental characterization; do what you can with it. This is our best shot at how the estuary works, and if there's some way to blend it in, either with management or hatchery operation, fine.

Bob Burkett My name is Bob Burkett, and I'm the Chief of Technology and Development for FRED, and I feel compelled to talk for a moment. I think we're avoiding the major question. Has anyone got any dollars? In my mind, the research questions are, I won't say simple, but I will say they're known. We can sit here and generate research ideas forever. Many of them seem to stay the same from year to year, but that's OK, too, because they've gone unanswered from year to year.

What do change from year to year, quite dramatically, are budgets. Not only FRED's, but the University of Alaska's and any organization's that you can name. We have priorities in terms of this topic area, estuarine survival of fry. We could key right in on it in a couple of seconds. But I must confess, we don't have any money to attack that question. I work on that problem, a couple of other people work on that problem, but just because we're kind of beating our heads on the wall doesn't mean that it's going to give a little.

Gary already mentioned that at a similar sort of workshop, I think a year or so ago, we came up with -- we being collective, not just FRED, but other groups, too -- a research design proposal. But so what? It was never funded. So I think one of the things I'd like to get out of the dialogue with other folks here is not so much that we exchange ideas on what research needs to be done, but more so on whether we can rank one or two pressing questions and then push forward, sort of in unison. Can I lobby someone for money to research estuarine problems? Can I say, "Why don't you call so-and-so at such and such a place and ask him what he thinks about that?" And if we're in unison, if we can get some collaboration on what we're trying to answer, maybe we can get the support of someone else also.

Ray Hadley That's what I very much hope at this particular meeting and the proceedings therefrom that we'll supply you with -- gunpowder to go in and lobby for funds for you, for us, and for the rest of the organizations represented here and others. Could we get back to that and get into some of those things that you've discerned as being potential projects, and see if we can find a consensus among ourselves as to which ones we might go after

first, with the best results? I think one of the worst things we can do, and something that has happened in the past, is to go to our funding sources with a universal project which is really what we want, but there's no chance that we'll get the money to do it. Can we go in with something slightly narrower in scope that is more fundable than that?

Derek Poon I'm trying to come up with a short-term approach, but that's kind of tough. Virtually everything that can be done in aquaculture has no meaning until you get to the returned marked adults.

Ray Hadley Well, something short-term, maybe. Is there something we can do about a better system of marking the fry?

Derek Poon Well, I was about to come to the short-term solution. No, I think perhaps, going back to what Bob said, it's really true that the funding is really tight right now. As a matter of fact, at one point we were pretty optimistic about taking the problem to the congressional delegation until we discovered that the National Aquaculture Organic Act of 1978 was vetoed by President Carter. And not only that, but the funding of that particular act, as you know, was almost non-existent. So that kind of took the wind out of our sails.

But I do see one area where we can make a pretty good case. We're in need of some R & D, and you've got to tie in the money that's already being spent, whether there's a chance of recuperating your investment. In this particular case I'm coming from a speciality point, of course, but we have a lot of aquaculture facilities that are already going on. They come at a pretty good price tag. We also have a lot of fry now that are being released at a variety of places. It's pretty much of a common concern among those who operate these facilities that we would like to have a little better predictability on the return. But usually people don't have the capability of getting data, and even more important, they don't have a format for getting that data. In other words, what are the pertinent environmental parameters that may be pertinent to predicting fry survival? We had a meeting in Anchorage in 1978 with the Commercial Fisheries Division, and I was able to sit in on the forecasting session. We talked about the possibility of using the data base that can be generated at these aquaculture facilities and -- this is exactly what Bill was saying -- trying to understand not only the artificial system but the natural system.

I guess what I'm proposing is that perhaps if we can tie in the current expenditures that are going into these facilities -- and I think that's fairly easily done -- and the value of generating specific environmental data, perhaps a short-term type of project that we can all get off on is to identify what that standardized format would be and what preliminary

equipment would be necessary to get that data. It may well be just plankton tows with temperature data. It may well be comparing the migration pattern of wild versus artificial fry. Perhaps this is something that the legislators would look favorably upon, if it's tied in the right way. Now it may not get us off the ground as far as finding out who might do it. That's when I kind of back off the table and let you guys go at it. But I think that getting the standardized format might be a start. I think it would make sense to people who fund this sort of thing.

Ray Hadley Is it possible that that could be an offshoot of the NMFS proposal? For example, a data bank situation.

Bill Heard Yes, it certainly could be. Each of us, each agency, has certain kinds and types of political constraints that we're working under that evolve with time, probably none more quickly or rapidly in recent years than the National Marine Fisheries Service has. In the last decade, we've closed down six major field facilities for environmental field research on salmon and retrenched to, if I might use the phrase, a shadow of our former selves. That's not necessarily bad; maybe it might hopefully develop into a leaner, meaner animal. Also, to relate in a real way to the needs, with cooperative involvement with various other agencies, the universal project doesn't exist. Given the general attitudes of basic science in our country right now, I don't think it will. I think we're fighting a losing battle there, and I believe we do have to identify what we can do and, hopefully, with as many barriers as possible down between agencies and a broader spirit of cooperation. Is there a potential in our respective agencies so that if someone, possibly Sea Grant, took the lead in the development of a standardized environmental assessment operation on a relatively low-key basis it could be done? What I'm speaking of is a log book format, where all of us who have people in the field, and the aquaculture corporation, and potentially the fishermen can take part in what we all consider to be suitably, but cheaply collected data. Is there some way that we could agree on methodology of collecting, say, salinity values, or oxygen values, or temperature values? Would it be meaningful, but still possible to be done by individuals? That would be a very worthy goal.

Jack Bailey I wonder if what Dick Straity proposed might not be what you're talking about.

Bruce Wing A large part of what Dick and I were discussing and considering in this environmental assessment program is aimed at obtaining and maintaining a uniform data base. We'd like to see it move a little bit more rapidly than a start from scratch. That's why this form has been designed. As you can see, it has a lot more information than just what to do with salmon. I think this work could apply to both natural stocks and aquaculture

programs. For instance, Bill Heard has worked for many years at Little Port Walter; Dennis Lund for three to four years at Sitka. They're building up a data base which might show trends. Also, Jack Bailey and I discussed the possibility of a plankton watch. For instance, Sitka has three years observations; Ted has three years in Prince William Sound. In Auke Bay we have data back 15 years. We were discussing how the aquaculture people could do some standardized reporting of environmental data at their site, particularly temperature profiles and salinity profiles in order to calculate sigma-T and measure stability, perhaps a standardized phytoplankton count, and a zooplankton measure. This requires a small effort by the hatchery staff. We may have to make these at least weekly. A collecting agency would accumulate this information and disseminate it. I don't expect the first year's data to allow management decisions to be made, but it would get them in the habit of making the observations that may be necessary for future management decisions. One advantage of this approach is that we could get broad area coverage. This would allow us to get a handle on year-to-year time variations because the blooms occur in one place before others.

Bill Heard

Well, isn't this what Ray was talking about when he asked if we could define, or come up with guidelines on some standard? I'm not correcting Bob with what Bruce and Dick have proposed here, but recognizing the fact that we've got a lot more activity going on in a lot more places, almost on a yearly basis, partly because of the aquaculture development and involvement in the state. I think that almost everybody involved would be receptive to attempts to collate and standardize as much as they can. You mentioned salinity and temperature. Do you have a suggestion on how we do it? Where do we take our temperatures? Where do we take our salinity? Those are some questions that I think we'll have to go to you for.

Ted Cooney

Let me just interject a comment here before we really get into this thing. That is, I think we ought to be cautious about developing priorities and list the parameters that we could measure as opposed to those that we ought to measure. We could send the fishermen out with a case of salinity bottles and a bunch of temperature measuring devices and literally bury ourselves in easily measured parameters that may or may not have any relation to what we're talking about. I certainly support the notion of site-specific records which, I think, over a period of time are really going to be important to the various hatcheries to kind of unravel what's going on there. But I think before we mobilize the fishing community with their thermometers and salinity bottles and their butterfly nets, we've got to think about this thing just a little bit and come to grips with the problem of hypothesis testing, perhaps,

rather than hair-root descriptions of the environment. I would guess that a small grouping of people who have a background of information could come up with a list of priority parameters that might, in fact, be very different than the ones that would be called to mind easily. But I don't think that that's the heart of it. We're in sort of a resource-limited situation right now, with limited dollars for processing samples. The easiest thing in the world is to go out in a boat, collect some zooplankton, throw it in a bottle and send it to Cooney to be sorted. Now Cooney has got to get his sorting center up to speed; he's got three or four people who are meticulously picking for weeks to tell you what's in that sample. So some of these things that look like easy ones from the start don't turn out to be anything at all. And from my work at Evans Island, it looked like it didn't matter to the salmon that were sitting there in that estuary whether we're going through a high period of zooplankton, or a low period. They were getting the same amount of food when they were sitting there in that ecosystem. So it may not be that you want to start collecting samples and plankton in hundreds of bottles to be analyzed.

Gary Freitag At Beaver Falls this year they released a few million chum salmon, and I was curious about exactly how much predation was going on. So I set gillnets out in the vicinity of the releases to find out exactly what kind of predation was occurring. There were pollock in that area; there were tremendous quantities of sablefish; there were also perch. Of all the samples, the pollock were, by far, the most vicious predators on the chum. They did quite a bit of damage. I collected approximately 15 fish, which isn't all that much, during the release. But each one had at least 50 or so fry. And many, many got away that I didn't catch. The surface of the water was frothed at one time with pollock coming up from the bottom to feed on the fry. So I think specific cases at each hatchery -- the type of release, how they're released -- are going to be characteristic of how much predation you have on your stock. With natural fish, I think probably predation may not be a serious problem in survival. Under the release conditions that we had, at least the one that I monitored, I would say that it's a serious problem. So I think it's going to be very specific to the type of release that you have.

I also checked the shiner perch which tended to swarm around the net pens where we were rearing our chum salmon. It looked like they would have been a really serious potential problem, because there were thousands of them just swarming around. I did some underwater observation of this. I collected quite a few samples, but I found that they weren't really a serious problem because most of them weren't eating salmon fry. Oh, they looked like they were waiting for our release, so I suspected high predation in the rearing pen area. But it wasn't really a serious problem. So it's all very site-specific.

Ken Leon

Some of this is pessimistic, so I'd better qualify it. I'm not against data collecting. I'd like to see a good data base, and we're eventually going to spend a lot of time and money to develop some facilities. But I see all kinds of problems in going at it broadly and looking at predator/prey, or predator/competitor relationships. It's nothing new in ecology that these things are in a continual flux or cyclic. Getting some data for a year or two or three on the amount of predators in an area, especially something that I'm concerned with -- a hatchery site, may mean very little because it's dynamic. It's not going to stay that way. You start off with a small release of fry at a place that may not have any natural fish. And I'm certain that predator abundance is going to change as that hatchery goes into a more productive load in 10 or 20 years. So the first year you say, "Well, there aren't that many predators." Well, that doesn't mean anything, because in 10 years there may be thousands of Dollies waiting out there. Every year you build up their populations. There are hatcheries in different parts of the state; each of them will have different problems. I've read in literature, almost every hatchery operator has different results. Whether it's weather or predation or fish mortality, incorrect timing of release. There are so many variables, it's almost incomprehensible to me that looking at a whole variety of things is going to tell us anything. Again, I'm not saying that we shouldn't do anything; that's kind of counter-productive.

From the standpoint of helping the managers predict runs, I think all this information is great; I think it can help them very directly. They're looking at a whole area, Southeast Alaska. So we have four or five hatcheries, and we're putting a lot of money into them. There could be a 10 or 20-fold difference in their results in these places. But I can't see finding something out in one place, and then generalizing it. I don't think it will ever work that way. I keep going, furthermore, from year to year where we have climatological differences. If we plan a release time, based on past data, we'll aim for a mean. Let's say, every year you have two or three weeks' difference in the conditions. You can't tell a hatchery manager that he can't release his fish this week when he wasn't prepared to feed them. Or you have to release them now, and throw away all the food you've got on hand. It goes on and on. A priority in my mind, something that might help in most circumstances, is to find out where the fry are feeding. In this case, I'm interested in where the fry from the hatchery end up feeding. See what's available from year to year, and don't worry about just doing something at the hatchery site. We don't know if the fry stay at the hatchery site. We've got reports of chum salmon moving 20 miles away from the release the first three days out. So the first thing we have to know is what's the behavior when they leave the facility, and where are they going to end up feeding? Once you know that, and

it's going to take a considerable amount of research and field work, then we can start homing in on who can take samples of productivity and when. In the meantime, as for the other stuff, if you have money, that's great. Get the backlog. But we can't afford to. We have four men in a facility. And they're working overtime to try to get their job done. There's no way they can go out once or twice a week and spend half-days doing plankton tows and drawings or preserving stuff for dying or filtering or whatever.

Derek Poon I'd just like to make a brief comment. I proposed an idea, the solution of which is going to be committee work, and the thoughts that I've gotten from various people are certainly very valid. But I didn't mean to take an idea and have it oversimplified. I appreciate your point, but the thing you've got to keep in mind here, from listening to Alan Kingsbury and others, are the number of variables used in some of those equations. We certainly could help that out in the overall picture. I think that's one of the key things to keep in mind, too. Quite clearly, as far as the hatchery is concerned, I understand that's site-by-site. There's no question about that. Whether the estuary is, in fact, important or not could well vary between places. I think Dennis has some numbers on Dollys that would very much impress you. It might even impress Bob Armstrong. I've seen some pretty fierce predation, a pretty big long picket line of cutthroat. But the exact meaning of this is not clear.

Ken Leon I have a point, if I may. Derek, you said that you'd like to get this information to help the natural system. I'm not sure if you mean that -- or do you mean help forecast?

Derek Poon Forecast.

Dennis Lund Yeah, well, some numbers have been tossed out on the Dolly Varden predation on the early out-migrant fry. This is a small sample, but no smaller than some we've heard. We sportfish the Dolly Varden at the hatchery outlet every spring. We force every student to go out and spend so many hours fishing. Within legal limits, of course. But in 1977 we sampled the stomach contents of 32 Dolly Varden over about a one month period and the average stomach content was 50 of our salmon fry. In 1978 we sampled 40 and the average was 62 fry. However, from a purely subjective basis, as Ken mentioned, it isn't static because the first year we released fry, which was in the spring of 1976, we hardly noticed any Dolly Vardens out in the hatchery outlet at all. And now it's so important that I have to screen if any fry leap out of any of the incubators, which always happens before they're ready to migrate out, because they're minced up before they can possibly get out through the estuary. I'm convinced that if you let fry dribble out early, it's deadly as far as attracting the Dolly Varden.

The point here is that I don't have any handle on what the turnover rate is, stomach evacuation time and so on. But it's not uncommon to find Dolly Varden that have, well, the highest has been 468 fry in a modest size Dolly Varden and not another thing in there. Again, that's site-specific. But it makes you wonder when you see something like that at the hatchery. How do any fish runs of up to 100,000 or more come back to Callean River when you've got 20,000 to 30,000 Dolly Varden in a solid black mass at the outlet of the stream and the water is just rippled with attacks on the fry? On the other hand, would you have 200,000 fish if the Varden were removed? But there's another factor, too. If you are talking about close to town, you might want to forget about predator control on Dolly Varden because there are other concerns besides just the hatchery. The Dolly Varden is an important sport resource in the Sitka area. And we've essentially shut up lately, except today, as far as to gripe so much about the Dolly Varden predation. The sport fishermen got pretty unhappy when we suggested that the Dollies could be thinned out a little bit. So we no longer talk about it, because we don't want to create any conflicts.

k Poon I think it's important, too, Ray, that in 1976, the first year those fish were released, the Dolly predation scared the hell out of the people at the hatchery, and the product of that release was the overwhelming return.

Hadley We'll start up again with Bill Heard's slides, and then we'll go wherever we go.

Heard I want to take about five minutes. A lot of people have asked me about the phenomenally high ocean survival of pink salmon that was measured at Little Port Walter this past year. Very quickly, at Little Port Walter there're about 35 years of data on marine survival of pink salmon. There are also a lot of freshwater data, and everybody's familiar with that aspect. But generally speaking, marine survival of pink salmon ranges from about .2 percent up to around 6 or 7 percent, with an average somewhere between 1 and 2 percent. Those are the figures that we've generally used in our hatchery projections. In recent years as we've gotten into aquaculture research work, we've been trying to measure this more closely with hatchery fish as well as wild fish. As I indicated before, if we do our hatchery work right, what we're hoping for is that our hatchery fish will behave as well as our wild fish, and we don't get anomolous behavior and that sort of thing.

This past year, 1978, we measured an ocean survival of 20,000 marked pink salmon. That was 14.5 percent of the number of fry released. These were reared fry, tying into what Dennis said about short-term rearing. And 14.5 percent of the fry

released with marks returned to the weir at the creek! Now that sounds fantastic -- except by playing with our estimates of wild fry out of the creek and unmarked hatchery fry, the actual survival of the whole number of fry that left that system approached 20 percent! That just staggers the imagination in terms of pink salmon biology. But from an estuarine survival standpoint, what I want to show is some information that Doug Jones put together and to which Derek Poon alluded. The outer coast the Baranof/Chichagof escapement-to-return ratio was 1 to 1.4. This is data from Doug Jones's analysis of the statement, estimates from the fisheries managers surveying streams in that area, Dennis Lund's survival at Sheldon Jackson which produced such a small return to the hatchery compared to the previous year.

Dennis Lund Well, it was actually about .3 percent overall.

Bill Heard OK, so it was a little bit higher -- .3, less than a half a percent. On the inside of Baranof a very high pink salmon survival, 14.5 to 20 percent of the fry at Little Port Walter, had nothing to do with the hatchery. In fact, I can prove to you that the hatchery activity actually hurt the survival a little bit, even though they were reared fish and much larger than wild fry. The whole inside of Baranof/Chichagof apparently had something happen that produced exceptional survival. Up in the Peril Strait area, where they had the even-year pink salmon fishery this year for the first time in, I think, about 25 years, the escapement-to-return ratio was 1 to 18, and in Tenakee it was 1 to 8. Another point: at the Auke Bay hatchery known fry survival was 2.8 percent, or was it 3 -- just over 3 percent. Now, in summary, it appears that in northern Southeastern Alaska from the outer to the inner side of the islands, there's a tremendous difference. It doesn't appear there was a tremendous difference in overall ocean survival. I submit that it probably was in early estuarine conditions. I don't have any idea what it was. But that is such a tremendous difference that I think that what you're after, Ray, in terms of trying to measure estuarine survival, is that if we knew what caused that kind of difference and could qualify it and predict it, I think that's the goal we would be after. I can't explain it, other than what I put on the board, and I wish Doug Jones were here. I'll stop with this comment: In previous breed years, 1975 to 1977, the outer coast of Baranof and Chichagof had extremely high returns of adults and apparently very high ocean survival and a known major return at Sheldon Jackson of 6 percent. So this is very dynamic, very real, and I think it's worthy of our efforts. I just hope we can come up with something we can sink our

teeth into. We know in the case of our work at Little Port Walter that it was not related to freshwater at all. In fact, freshwater survival was very poor. And in general, the pre-emergence indexing (and maybe some of the commercial fish people can correct me if I say this wrong) did not indicate what turned up in Tenakee Inlet and Peril Strait. That was sort of unexpected. And, as I said, it was the first fishery in about 25 years in an even year in northern Southeastern that they caught 2.8 million fish primarily in Tenakee Inlet and Peril Strait.

One other thing, the near Little Port Walter complex and adjacent system Lovers Cove Creek, which normally has between 5,000 and 10,000 pink salmon on an even year and apparently had about that level in 1976, had 100,000 fish this past year. Something just happened. We don't know what it was, but it was just phenomenal and I, for one, would like to know what it was.

Chuck Meacham Speaking of interesting survival phenomena, it's probably worth knowing what occurred in Bristol Bay this year with pink salmon. Typically, there are not a lot of pink salmon there. The average total run is on the order of a million fish. They're all even-year fish. Prior records for total runs were on the order of 5 million fish. In 1976 there was an escapement of one million fish that resulted in a return last year of 15 million pinks. So here again we had a 15 to 1 return of pink salmon which, at the level of return, is at least three times higher. It's a real phenomenon. I don't know really what occurred, but I expect that it naturally has to do with ocean conditions. Whether it be estuarine or high seas, I don't know.

Dennis Lund I might add something to that with regard to the Starigavin Creek situation. As I said, we have limited experience as far as the number of years at Sheldon Jackson, having only had two groups of fish come back. We're trying to say, well, how come Starigavin seems consistently to produce a fair to good run of fish, when we see Salmon Creek and Indian River go up and down? Some people have said that it's because it's logged off. But nonetheless, one of the students looked at the fry out-migration timing in the spring of 1977, resulting in the fall of 1978 run. Our hatchery fry went out 35 days prior to the peak of Starigavin fry out-migration. A good portion of the reason for that is that the stream normally runs a half to one degree colder in the winter, so we get a much faster rate of development of the alevins. So whether or not that timing difference makes any difference, I don't know. But I do know, based on marked fish return, that there was no difference in hatchery fish of the 1976 release in 1977, with three weeks difference between the marked early fish and the late fish, with some early fish that had been held for three weeks and fed and

released with the late unfed out-migration. We got .15 and .16 or .17 percent return of marks and looked at about 6,000 fish, which was every fish that came back to the area. So three weeks difference didn't seem to make that much difference.

- Floor I understand that the average size of the outside fish in that area was smaller.
- Bill Heard In Southeastern this past year, the run, particularly the early part of the run, of course, had a banner year, the highest in 30 years, and produced small fish. I guess the latter part sort of made up some of the slack. But that's an interesting point because we tend to think of survival in relation to growth, and conditions that are good for growth means good survival. The fact is, there was disparity in two different parts of northern Southeastern where we have very high ocean survival and very poor ocean survival, and yet in both cases we have small fish. So good growing conditions might not necessarily mean good survival.
- Ray Hadley That goes along with Ted's idea concerning the fact that food might not be a limiting factor either.
- Ken Leon At the levels we're dealing with I don't think it is. It just makes sense to me that predation has more to do with where the fish are disappearing to.
- Bill Heard But we've had two or three people give us evidence that brings up the other question. You could say, is it predation or isn't it? If it isn't predation, what is it?
- Ray Hadley We're still dealing, though, with whether we have a test here that could be applied. We do have some data, and chances are we will have in the near future, I hope, some similar data, where we have a very close proximity, geographically, with very different results. And getting back to Ted's comments as to site-specific studies, there's an ideal situation. What can we find different from one site to the other, be it climatological, be it predator-prey relationships? I don't think we've cleared the food completely. Should we check the food source? Storms during emergence? Who knows what, but is there some correlation we can go into for further research? I think that could be really important. I don't know how much of that data is available now. The thing that Derek brought out is that if we had some means of collecting that data on a low scale in the future and if we had a good feel for what we were looking for, then a post-facto evaluation could occur.
- Herb Jeneke We do have that data. Let's look at it. We have our representative down in Monterey (California) Fleet Weather Center. He

gathers all the meteorological oceanographic data in the world. We have all the data stored in computers down there and can supply you with average sea surface temperatures, air temperatures, upwelling indices anywhere in the world. These records are available for 60 years and they are the most complete records of oceanographic data in the world.

So, you have it. You don't have to start off at a point in 1978 with survival of this or that. We have long-term records for Little Port Walter, for 35 years of ocean survival data for Bristol Bay from two stocks. Why not start at that point, and then get your methods down on how you want to collect it, rather than having a big conference and saying, well, we don't have anything here. We only have two or three year's records here, and two or three records here. We have it now, and you can sort it and it's available and we have somebody, Dr. McLean, down there whose task is relating weather to fish survival.

Ray Hadley Well, that would be the place to look for the climatological situation. I think we can try and see if there are other sources of data available. The interesting thing I find from this data though, we might be able to eliminate some concerns for high seas survival. If we can show that both of those stocks with a high return and low return are not likely to use vastly different areas of the ocean, although I'm not so sure we can say that off hand. If we could, the conclusion is obvious; we should be looking at something a little closer to home, which is, I think, why we decided to limit ourselves here to the estuarine situation.

Bill Heard I know Mr. Urquhart indicated that we might be looking too close in; the problem might be in the ocean. And I indicated earlier that my interpretation of this data was not ocean, but early estuarine differences. The central B.C. work that Bob Parker did for about three groups of pink salmon; we keep talking about pink salmon. I emphasize again that we've got four other species that are involved in this. But Parker indicated in his specific study, which involved the marked recapture in the estuarine environment, that essentially in the first 45 days of sea life roughly 70 percent of the total marine mortality occurs. And that's really the only way that we can measure estuarine apart from total ocean survival. I don't know if anyone is proposing to do that.

Herb Jeneke I proposed that, you recall, in 1971 in Bristol Bay. After we'd done the estuarine studies for about five years with Jerry Pella, we attempted to get the direct cost. It turned out at the time it cost \$300,000 just to work with one or two stocks in 1971 and that's probably doubled by this time. That's the problem. We always have trouble at this point.

Ted Cooney Again, it occurs to me, sitting here listening to the dialogue, that a possible next step would be to convene what would be, perhaps, a pink salmon or pink and chum salmon or all-species-considered science symposium, addressing in a much more specific way the questions that we're sort of popping off the tops of our heads today. Is it not possible that the notion that Herb points out, that data exists that has not been examined in quite the way that it might be, would allow us to come to that meeting and actually draw some conclusions about the relative importance and ranking of the many parameters that we're talking about here? It just seems like the thing that's missing is a little rigor in this discussion, and I think that each and every one of us perhaps has some documented points that would lend themselves to an analysis. But I don't think that it's going to happen at this meeting.

Bill Heard Following your thoughts on that, perhaps the next pink and chum salmon workshop might be a worthy forum to do as you're suggesting.

Ted Cooney I think it would be useful for those of us who don't normally get together and talk about this problem, if such a symposium were planned. Then it would seem that it would be necessary for many of us to get together and deal with and prepare information on some of these studies that were done independently, but which overlap in terms of their interests and results. I think that might be one of the first ways to integrate on a scientific level the workers who are now sort of turning out results in this area. I would hope that if such a symposium was to be planned, a product would emerge from it, some kind of document that would represent the collective work that had been gathered together, perhaps followed by some recommendations as to where the scientific community might go with this sort of thing. That would provide the rigor necessary to dig into these problems and take them, in a way, a bit more seriously than we're able to take them today.

Bob Burkett Let me take a pessimistic view. Given a blackboard somewhere here in the room, we probably have enough talent assembled to model in half an hour all the boxes needed. We could pretty much identify all of the variables, all the transfer equations that would be needed, the whole thing. Yet, we would still go away asking ourselves the question, "How are we going to get this funded?" And I think that's the primary question. You know you can deal; you can go on and on. There are so many nuances to the life histories and population dynamics that overlay all the environmental variables, etc. But nothing happens unless you can identify or ferret out who's going to fund such a massive effort.

 I think that would be the conclusion of the symposium. As Herb has already pointed out, it's complex. How many times

do we need to say that? It's expensive. How many times do we need to say that? Who's going to fund it? How many times do we need to say that? And what we seem to need is some creative thinking about how to put the money to bear on the problem. We've got all the people. We've got a lot of the fragmented sorts of pieces of information from the past, some not as fragmented as others, some data sources that are now being put together that maybe we haven't really examined closely. But what we haven't done is to bring some creative thinking to the problem of how we really are going to attack this and get it rolling. In other subject areas, I've been to meeting after meeting after meeting and symposium after symposium, and nothing ever gets done until those people come to grips with that problem. They never seem to want to do that. I hate to be the crass person talking about money, rather than concentrating on biology. But unless you put some creative thought to that, you're going to just be going to meeting after meeting after meeting. And 20 years from now we'll be as frustrated as we feel today.

I don't think there's any cheap way to do this. I don't think you're going to get a lot of free labor and this and that. We'll have to pay the price and have to convince somebody that it's worthwhile. Until you start examining the problem that way, you're not going to make it. I think it's fun. I get a real big kick out of going up to the chalkboard and putting the boxes up there and saying, "Look, I have to know this, to get this, etc." It's neat. It's a lot of fun. But then I, like you, erase it and walk away because nobody's making it real. I think it would be nice to have a jam session, rather than a symposium, on the biology of the pink salmon and all the salmon species. It'd be nice to have a jam session on creative thinking to get some of this stuff funded. New sources of energy, "dollars," to force this whole thing into motion. We can all get together again six months from now and have another fun time and talk about the biology and this and that. That's fun, too, don't get me wrong. I'd enjoy it...

Dennis Lund

The thing is though, Bob, the only way you're going to find out if somebody's interested in funding something is by saying, "Here, we've got a plan. Here's who could do it. Here's who'd be responsible for this. Here's who'd be responsible for that. And here's the cost/benefit ratio," and so on. If I go up to Sheldon Jackson's administration and ask for money for the hatchery, they say, "How much is it going to be worth to us?" And they also say, "How are you going to do it?" They want to know how. They won't say, "Yeah, we might be interested in giving you another \$30,000 for work around the hatchery. Come up with a plan of what you have in mind to do." I really think that you have to have a strong approach to that.

Bob Burkett I wouldn't deny that for one moment, not one moment. I'm just asking you to step out a little beyond that and ask yourself, "Even if I came up with this plan, are there any institutions out there that are going to make it happen and this and that?"

Bruce Wing You've got one, two, three, four institutions right here, all of which have specific money for research. You're already partially funded.

Bob Burkett Partially, that's a very good word.

Bruce Wing Another point I would like to make -- and this is something that I said last year, and I said over and over. On site-specific things, every one of these hatcheries that we have working here has to be treated to some extent as a research experiment. Therefore, as I understand the aquaculture bill -- both bills from the federal and from the state -- you are required to take certain types of data along with what you're doing. And if you're going to be addressing environmental problems related to your releases or whatever they are, even if you're worried about what's coming back to you, you're going to have to be looking at that data and that information and using it. So I suggest that you are already funded.

Bob Burkett I would suggest to you that you're painting a picture of oversimplification.

Bruce Wing Bill and Jack and Herb and I and the rest of us here who are federal employees are funded to do that. A large part of what Dennis's group is doing is to train half these operators in what they should be doing. And part of what they should be doing is that monitoring and that research aspect. He's obligated to perform these tasks. That's specifically what Ted's group is there for, to do research. Now Ted has to fight for his funds from NSF and other people.

Bob Burkett Hey, my creativity at this meeting is coming through and trying to tell people that you need some creative thought out here on how to identify new funding sources. If you've got the bucks, don't do it. I'm not talking about \$20,000 to support a couple of graduate students here and there. I'm waiting. I confessed earlier that we have a number of research questions that we'd like to see answered, too. We don't have the bucks.

Ray Hadley I think that the question here develops into this: When one presents a proposal, either in the form of a budget to the governor or to the president or a proposal to NMFS or Sea Grant, one is dealing with a limited amount of resources. And it is up to the presenter of the proposal to convince the funding source that his sense of priorities is correct. The only way I can imagine doing that is essentially through a

meeting like this, where we might adjourn saying -- and I hope we will -- that the next place to look in this problem of salmon survival, the highest priority area we can look into is estuarine survival. Break it down further: What are the little boxes that Bob can draw up on the board? What boxes can be filled? What is the cost of filling those boxes? What is the return on filling those boxes? With that information, I think anyone putting in for funds -- federal, state, or federal grant funds -- stands a good chance of getting funded. What he's doing is rearranging the priorities. That money is going somewhere. As limited as it is, it's going somewhere. To be sure it's going where you want it, you need to defend your priorities.

Steve Norrell This meeting is getting to sound uncomfortably like meetings that I had to sit in on about eight or nine years ago -- Tundra Biome planning meetings -- and sounds like everyone is trying to compare contradictory data. We've heard contradictory data concerning the effects of Dolly Varden survival in estuaries, etc. Sounds like we're at the point where we were about eight years ago.

One of the problems I've had sitting on the Sea Grant committee is seeing to the relevance and the appropriateness of some of the proposals. It's very difficult to do when there is conflicting data, when somebody wants to measure the population of Dolly Varden because they eat a lot of salmon fry, and somebody else says they don't eat any. So I would suggest that at this time we begin to find a way to cope with this thing.

Bob Burkett I think your comments are very interesting. You've touched on a program that I had some interaction with several years back. I don't know your history or complete association with IBP but if you have a great deal of familiarity with it, perhaps you could tell us about the genesis of that and the magnitude of the questions that were attempted to be answered. A good many of them probably weren't. How that all came to be, how it all got funded and how many different people came to play on that whole sort of thing. Can you think of any other programs that were given such a high level of funding from the federal government as what NSF spent on that?

Ted Cooney Some of the IDOE projects have been funded at far higher levels than that. That wasn't the biggest project that ever came out of the National Science Foundation. And it wasn't a particularly successful one either, as it turns out. The modeling effort didn't solve all the questions.

Bob Burkett I would agree. But it was a large amount of dollars brought to bear through a number of institutions and a number of different people to resolve some of the problems. In other words, somebody got over the hump in terms of which agency is doing what. It gets complicated when you've got people all over the world

doing the things -- all over the U.S. But nevertheless, there was a group of fellows several years back that sold that idea. I'm not suggesting that we go to NSF in a similar fashion. There are alternative mechanisms to accomplish what we'd like to accomplish if we could just seek them out, or maybe even create them.

Ray Hadley I'm not convinced from my position in Sea Grant that bigger is better. I'm not convinced that we're at a stage to even think of bigger. I'm rather more convinced that what we have seen in the very recent past and what has gotten us here has been some relatively low funded, very successful, often site-specific studies that have given us all the information that we have been sitting around here discussing this afternoon. And my question is, what others of these types of studies can be done now? I think, again, the funding agencies are much more likely to fund something like Ted's three-year project at Prince William Sound. The small portion of CURVES, which I'm not so sure is small in proportion, but that portion which is salmon certainly isn't a Tundra Biome-scope project. Is there something that can be done? Can we here propose potential projects that would be fruitful in predator relationships? Or, as Herb mentioned, a project which would cost not a great deal to take data that already exists on climatology and salmon returns? Glue them together. We can proceed. We don't have to stop, waiting for the big bucks.

Ted Cooney I'd like to reemphasize and submit once again that it seems to me what's missing here is the synthesis of these very site-specific and sort of dangling data sets that we've alluded to. We've seen some slides. We didn't see the whole salmon fry-survival story today, I don't suppose, unless it's more impoverished than I think it is. There's a great deal of information that wasn't brought out here. It would seem to me that what we need is a synthesis of that information by those people who are interested in this problem as sort of a starting point to decide where it is that we want it to move, and what direction future studies are to take. That was my idea of the symposium. I don't think that it has to go to the Northwest Pink and Chum Salmon Workshop. I think it can stay entirely in-house in Alaska and involve the synthesis of the information that we've already got on hand.

Herb Jeneke Is this the last time we meet again before the pink and chum workshop? You have Sea Grant; you have the University of Alaska, FRED, Alaska Department of Fish and Game, and NMFS. Why not select representatives and have a meeting in two months or three months and see where you can go? Rather than meet every two years, or one year.

Ray Hadley I'm not so sure that from my own point of view that that's necessary, though it might be the best way. I've met so many

people now with whom I can correspond in a fashion that I hope will help our PIs at the University to keep in touch with what's actually going on. And I certainly intend to do that in the near future. I do share Bob's attitude somewhat about meetings. They do end up having an emphasis of their own that sometimes just floods the information, delutes it to a point where frequently when you get out, you're not sure where you've been. You've been sitting in a hot room all this time and that's about it. I would like to propose that the participants, including the audience, think about a number of aspects of what we've discussed today. This is something we've kicked around -- we kicked it pretty good, as a matter of fact -- the idea of whether we can make use of the data that is routinely being collected in a unified way. Can we improve that data? Can we suggest data that would be more useful to us from our present point of view? Can someone like Sea Grant act as a coordinator to get that information together? Can we propose a more serious look at this predator situation, even if only on a small scale? Is there something missing in previous studies which one can now pursue that might tie it all in together and remove the conflicting information?

- Ken Leon You said, can we tie things together by supplying missing points? We don't need the big picture, you're saying. Let's go for the little thing that we can do. Well, if you examine two or three variables that you can afford, and you hit one of the critical ones by luck, then you're all right. The next year you try something else. But each time, the work you've done before is not necessarily going to be applicable to future work. I mean the backlog. This whole thing is correlation, multiple correlation, the way I look at it. If you leave out variables each year, what you did gather is going to be of very little use in your next design, unless you increase your variables in looking at it.
- Ray Hadley But is it not possible to increase variables?
- Ken Leon Well, yes, but you're just making work for yourself.
- Ted Cooney Well, it's possible to decrease the variables, too. That's the name of the game, to make this complex thing as simple as possible.
- Ken Leon In my opinion, it's so complex, it's mind boggling. I don't know how we could do that. I guess I'm sounding negative, but it's not simple.
- Ted Cooney I realize it's not simple, but it's not something that you just sit around and conclude that it's mind boggling, either.

- Ken Leon I'm trying to say that you just can't go for the little things. You've got to get funding on a large scale and build something. I don't know how big Jack's going. I think he's going a lot bigger than we're talking about. It might solve your problem of keeping graduate students going. This isn't maligning anything, and you get projects, and you're learning things. But you're not answering my questions, I don't think. You need the big picture to know why these fish are coming back and why they're not coming back, unless some of you guys have a lot more intuition and you can take on two or three variables that are going to make the difference every year. I can't do that.
- Dennis Lund One time I sat in on this board meeting of a fledgling aquaculture cooperation, which has become huge since I left -- I don't know if there's a correlation there. And the board of directors was sitting around losing money, and they were worrying a lot about what was going to happen next. One fellow made the statement which I've heard him say many times and which may not sound appropriate here -- we can talk as long as we want about the difficulties and so on. But his comment was, "Well, let's do something, even if it's wrong." Because you don't learn unless you make a mistake. You can sit back forever and wonder about a question, but unless you at least try and answer it and then find that that answer was wrong, you can't ask another question until you have found whether or not the first one was appropriate.
- Bob Burkett I find myself at odds with that philosophy.
- Ray Hadley Based on that, maybe I'm pushing, would any of the panel or the audience care to guess, assuming that one were to take a small scale approach, what the next brush stroke would be to help to create the big picture?
- Ted Cooney Well, again I would say that what we need is to get together and present the science of what we have in hand already; that several scientists from state and federal agencies and those who are involved with the University system would present their raw data and their synthesized data sets. It wouldn't be just a meeting. We'd come and see what's going on; we'd present those data and critique them. Then, hopefully, the product of that session would be a list of factors that seem to be important. That would be the basis, then, for developing a plan to include a budget that would begin to wedge further into this problem, which I agree is a tangle.
- We live in a statistical world and there are hundreds of factors that are really involved. The game would seem to be, either by sheer luck or by cleverness, to filter out those signals that are most important in this problem. And unless it's vastly

different from most biological systems, there are going to be a few signals that are very important and a lot of modifiers. The question is, if we were to sit down now, could we begin to identify the few important signals as well as some of the modifying factors? On the basis of that, could we put together either a statewide plan for a further solution of this problem or individual plans within the units to handle? I don't know where it would go. But I can't imagine that we could proceed much further without really knowing what we have right now, and on the basis of that information, making some effort to identify important factors and propose to address them further.

Ken Leon Just to clarify that statement, from our point of view. We're attempting to collate data and it's taking the first attempt to get this thing going about a year and a half. We're still just starting because of funding, mainly, and I don't disagree with what you're saying to do. I spent everything we had on it, but it's just not done that way. So for us to supply that information, I guess we're looking at years, not weeks or months. We can't supply that information within the next few months.

Bob Burkett That's very well put. How much information do you think has been produced on salmon biology?

Ray Hadley We will certainly consider a proposal from you or anyone else as a joint effort with data collected by anyone else to work it up. One of the reasons we held this meeting was to essentially identify maybe a backlog where the information is sitting now.

Bob Burkett Let me see if I understand what has transpired here this afternoon. When I first came in, we outlined a number of questions that were unanswered because there are no data. And then we talked a little bit about maybe ranking research needs to acquire some data, because there are no data to answer the question. And now we've come full circle back to collating the data that hasn't been collected to answer the questions that we were addressing earlier in the afternoon. I'm lost.

Ray Hadley OK, I'll say one thing for sure in closing, and that is I know what my next step will be. We will take these tapes back, and as best we can, attempt to transcribe and to some extent filter. Then we will get back to all the participants here and those in the audience and anyone else who wishes to can request a copy from Sea Grant of what was said. Having the benefit of the tapes in my hands, I suspect I'm going to come back to all of you with more questions. I'm not pessimistic enough to think that that will be totally futile. I intend to ask more questions, even if only for my own benefit. I wish to thank you all for participating, including the audience. I am quite satisfied that this was not a waste of time, but something good will come out of this, even if only learning who else is in this same bag as the rest of us. Thank you.