U.S. DEPARTMENT OF COMMERCE

REPORT OF THE NATIONAL WORKSHOP ON THE CONCEPT OF OPTIMUM YIELD IN FISHERIES MANAGEMENT

PART II

HOUSTON, TEXAS

June 6-10, 1977

U.S. DEPARTMENT OF COMMERCE

REPORT OF THE NATIONAL WORKSHOP ON THE CONCEPT OF OPTIMUM YIELD IN FISHERIES MANAGEMENT

PART II

HOUSTON, TEXAS

June 6-10, 1977

Preface

This document constitutes the completion of the Report of the National Workshop on the Concept of Optimum Yield in Fisheries Management. We would like to thank all of those who contributed to the workshop for their time, effort, insight and expertise. Special thanks go to Mr. David Wallace, Associate Administrator for Marine Resources, NOAA, who provided an initial stimulus for the workshop and whose office provided the funding for the project. We hope that the workshop and this report will serve as stepping stones to a clearer and more useful concept of optimum yield in fisheries management.

Workshop Co-Chairmen

Henry Lyman, Chairman,
New England Fishery Management Council

Brian J. Rothschild, Director
Office of Long-Range Planning and Policy Development, NMFS

Technical Session Contributors

Lee Anderson
L. J. Bledsoe
J. W. Devanney, III
Low Lee Loh
Michael K. Orbach
Susan Peterson
Robert Siegel
Irving Spaulding
Michael Sissenwine
Courtland Smith
Edison Tse
James Crutchfield

Dayton Alverson
Don Bevan
Peter Eldridge
Richard Shomura
Leah Smith
Spencer Apollonio
Eugene Cronin
James Cato
Arthur Dammann
Don Collinsworth

Council Session Discussion Chairmen and Contributors

James Crutchfield
Richard Stroud
Henry Lyman
Don Bevan
William Gordon

Donald McKernan
Christopher Weld
William Mustard
Harold Lokken
Lee Weddig

General Editor

Michael K. Orbach, Social Anthropologist,
Office of Fisheries Management, NMFS

Table of Contents

I Introduction

As we pointed out in Part I of this report, the Optimum Yield Workshop was intended to be a forum for discussion. The technical presentations, the Scientific and Statistical Committee panels, the presentations in the Council session, and the accompanying discussions ranged over a broad spectrum of topics. While all of these presentations and discussions were related to the concept of optimum yield, the task of integrating the points which were raised and discussed into a workable definition or approach to optimum yield management is still before us.

The approach we have taken in this report is to let the summary, abstracts, and questions, concerns, and points of discussion which were presented in Part I of the report stand as a general record of the workshop in skeletal form. In order to expand upon many of these concepts and ideas beyond a description of the parameters of the problem Part II of the report presents full texts of many of the papers given in the technical session and edited texts of the Council session discussion leaders' presentations. Rather than summarize this material, we have in general left it to the reader to extract information relevant to his or her own concerns with respect to optimality and optimum yield.

Even with the addition of this material, however, there remain significant points--some of which were raised in the workshop--which are important to the definition and implementation of optimum yield management and which may not be adequately represented in this report. Can an optimum yield level be above a maximum "acceptable" biological yield, and if so under what conditions? How do we develop better communications between user groups and management and legislative entities? How, and to what extent should we institutionalize public participation in the management process over and above representation on the Councils and through public meetings? What role should foreign fishing and foreign fishing interests play in optimum yield in areas such as allocations, foreign relations, the reciprocal effects of regulation, joint ventures, and others? How do we deal with the innovative capability of fishermen, both in circumventing regulations and in the rapid technological advance which may lead to resource depletion or overcapitalization? How do we take the interests of the States and the functions of organizations such as the Office of Coastal Zone Development into account in deriving an optimum pattern of use for our fisheries?

This is only a partial list of questions which participants at the workshop were not able to adequately address in the short time they were together. As Donald McKernan mentions in his summary of the workshop, the task of further exploring optimum yield in fisheries management must be taken up by all those concerned with fishery systems. NMFS and NOAA are currently developing suggested guidelines for the contents of fishery management plans, contents which include the determination of optimum yields. Several universities are planning seminars and symposia to explore such matters as sociological factors in optimality and the application of bio-economic modeling to decisions concerning optimum yield. These, however, are just a beginning.

If optimum yield is to become a workable and useful concept, three general processes must be developed. First, a general program of research in biological, social, economic, and ecological aspects of fisheries systems must be carried out and balanced in such a way that data and information becomes available to adequately incorporate factors from each of these areas into the management process. Second, the methods of disseminating this information to all sectors--public, governmental, industrial, commercial, and all levels--local, State, regional, national, and international, must be explored and common understandings and working relationships established among all of those who bear the responsibility for fisheries activity and management.

Finally, the available information, the theory of optimum yield, and the process through which it is derived must all be recorded and communicated to the public at large--not simply to those involved in fishery systems--in order to raise the general level of public awareness concerning the careful and productive utilization of our natural resources.

II Summary Presentation By Donald L. McKernan

Professor McKernan's summary was the last item on the workshop agenda. In it, he assumed the very difficult task of synthesizing over 900 pages of dialogue concerning a subject of immense complexity.

Since he performed this task so well, not only giving a broad summary of the points of discussion but also expressing much of the tone of the workshop and the common feelings of its participants, we have given the text of his presentation a prominent place in this part of the report.

Even though Professor McKernan's views, impressions and conclusions may not be shared by all of those who are involved in fishery activity and management, we hope that his presentation, along with the material in the rest of this report, will serve as a reference point in the evolution of the concept of optimum yield.

DONALD L. McKERNAN

Director, Institute for Marine Studies

University of Washington

I have been given the enviable task of trying to put together a summation and some thoughts on the whole week's discussion.

I have been tremendously impressed by the opportunity to discuss questions of common concern to people from such far distant places as Guam and Hawaii, as well as such places as Maine, Florida and here in Texas. That in itself is to me a great opportunity.

It seems quite obvious, though, that the purpose of our discussions during the week has been to take a look at the optimum yield concept and to see how we are going to deal with it--how we are going to deal with it in two cases. First, a technical point of view--how are our experts going to deal with the problem? Secondly, what should be the nature of the interaction between the technical experts and the Councils?

Once again I point out to you that the people here have been good in this respect. That is, we have had people from government and university laboratories who are in fact engaged in drafting the management plans, and who were instrumental in establishing preliminary management plans. But, in addition to this, some of us are very closely associated with the Councils. We have industry representatives. We have got a mix so that we can take a look at the optimum yield question from many points of view. And it is obvious that both Hal Lyman and Brian Rothschild have brought together this meeting of people for that purpose. That is good in itself.

It seems to me that the overwhelming question that has evolved during this particular week is how we are going to develop a common approach to this very complex concept--the optimum yield concept, a name that has been around for quite a long time. Many of us have talked about it and thought about, criticized it. Now, it is in the formal law. It must be applied, or the law itself must be changed.

The discussions have brought out the view--perhaps the consensus, if I can use that term--and I would expect you to correct me if you do not agree--that we do not seek a simple formula for optimum yield to apply on a national basis. But, we do seek consistency in the approach to this particular term and its definition in the law.

In the technical discussions the same thing was raised time after time--do we want to establish rules, rules which would be rather rigidly applied to all of the Councils? We essentially rejected that. We said no.

But, on the other hand, we wanted to understand the kinds of things that are going to be going into the approach by each Council. And we ought to have a consistent approach everywhere. It seems to me that makes a good deal of sense.

It is the Secretary in the final analysis who accepts these plans for the nation, and implements them. If there isn't some consistency in the approach to the problem, we cannot develop a key to the situation. Without that type of approach, those of us who are on the Councils, who have a primary say in establishing the plans, may experience a divisiveness which would provide a dilemma for the Secretary. Which approach is going to be followed? Which approach shall the Secretary accept, and which approach shall be rejected? Should the Secretary reject them all and come up with an approach of his or her own?

The extent to which the Councils can look at the problem in a common way, without an oversimplistic view that we must apply absolutely the same rules, or give the same weights to the various factors involved in arriving at optimum yield, will be the measure of our success. Out of our discussions this week has come a fairly clear consensus that we want to approach the problem in the same way. But, the weights that we give the recreational gains will be quite different between fisheries, and between Councils themselves.

The application of optimum yield that has come out this week must consider the allocation of benefit of the fishery resource among fishermen, among recreational users, processors, and in fact, must consider the question of the markets themselves--many markets. We have also made it quite clear that we are concerned about the consumers. All of these particular matters came out in the discussions among our economic advisors. We must do this in some rational economic fashion.

I concluded from our discussions this week that the question of the foreign fishermen and their allocations is essentially incidental to the achievement of optimum yield. The Act itself, and the objective of both the technical committees and the Councils themselves in establishing the fishery management plans, is to establish the optimum yield. To establish the surpluses from these optimum yields is essentially a secondary consideration of the plan. Obviously, they will be taken into account in terms of achieving the optimum yield itself.

It was pointed out in several different ways--it is hard to summarize and describe--that optimum yield does involve tradeoffs. In the end it really means that no user, no domestic user--commercial, recreational, processor, consumer--is a clear winner. It becomes clear that the allocation of optimum yield among the domestic users does become a task of the Councils in drafting the fishery management plans.

It is said that the final determination of optimum yield--and it's a statement that I think we share in common--that in the final analysis, it does contain judgmental processes, no matter how precise or quantitatively we attempt to fix the whole. In the final analysis there are judgments that have to be made.

But, these judgments, of course, can be made within limits. And the limits of these judgments can be narrowed by the technical analyses themselves. In addition to this, in determining optimum yield both the technical people and the Councils are impeded further by constraints which are applied to them in judging optimum yield. These constraints are added by the law, and include the intent and the history and the standards that are applied under the law itself.

The technical discussions have touched upon factors relevant to optimality. Our technical sessions early in the week proceeded in a rather more liberal fashion than the general policy oriented discussions we had in the last couple of days. It seems to me that MSY came out as a sort of dirty statistic, one which wasn't going to be very precise, and which had all kinds of problems associated with it.

Yet, I saw a reluctant acceptance that MSY was a reasonable basis. Obviously, it was required by law. But, even though it is required, I gained the impression from the biologists and the statisticians present that they were willing to accept the challenge to develop reasonably practical models to apply this particular concept in spite of the problems of the various estimates that were required to be put into these models.

Economic considerations were discussed at some length by some very knowledgeable experts in the United States, who made a point--and I do not detect any great objection to this--that we must maximize the values of the goods and services produced to the extent possible and within the limits of--if I can use the common term--compromises that must produce the final product of optimum yield.

Capacity was discussed at some length. Having read and listened to what we have said, it seems that one needs to be a little bit careful and not view capacity as the likelihood of an annual catch. That is to say, that capacity of a fleet may be far beyond what it in fact will harvest in any one year. So, in applying capacity to our optimum yield, we must certainly consider the levels of the domestic catch. And this was brought out in some of the discussions. A number of people in considering the question of capacity--and I thought it was discussed in some depth--mentioned that it could be estimated roughly on the basis of past catches.

Of course, once again, there was reluctance expressed among the technical people that the amount of the fishing power available for any fishery was not in itself a good measure of the fishing power to be applied in any one year. In fact, one ought to look further, and one measure of that was what the demand was, what the sales were, what the catches of the fisheries had been in the recent times. One has to consider, in addition to the capacity of the fishing fleet itself, such things as the processing and distribution system and the market demand on that capacity at any particular expected price.

Obviously, then, in determining optimum yield, in addition to considering the maximum physical yield that we are going to achieve from any stock, or fishery--that is MSY, maximum sustainable yield--in addition to modifying this by the economic considerations, we are required by law to include the social factors that might impinge upon considerations in establishing optimum yield.

I was struck by the confidence of the economists that they in fact could be helpful and useful and could quantify the economic factors that needed to be added and subtracted from the maximum sustainable yield. I came away from the study of the documents and the discussions with the feeling that Crutchfield, Anderson, and other experts had discussed that problem. In fact, most of us in the Councils did not disagree that we could consider that the tools were available to adequately consider the economic factors.

And I learned a great deal from the brief, and yet I thought, excellent discussions of the sociological considerations, the social factors. There were some problems, at least from my point of view, having been in fishery management for many years; some of our sociologists and anthropologist who spoke to us felt the social factors have only begun to be realized as being important. I put this in quite a different way. I would appreciate some comment on this if we have an opportunity for discussion.

I think this is kind of nonsense, that social factors have in fact dominated fishery management decisions for years. Take, for example, in recreational fishing and game management the social factors and people factors are very, very important. That has been true in fisheries as well with such things as the thirty-foot boat limit in Alaska, the setting aside of most of the total allowable catch of anchovy in Southern California--these things have in fact been considerations of social factors involved in fishery management.

I think a better way to describe this would be that what we doing is that we are recognizing the importance of quantifying these particular factors. Once again, we come back to a very important concept. In the case of social factors we are recognizing and trying to assess the appropriate weights on the social factors in relation to the relative importance of both biological and economic factors and, hopefully, in the final analysis, ecological factors as well. We need a good deal more study in these matters.

I was very much heartened by a number of points that had been made during the course of this past week. It seemed that the sociologists who spoke to us about these questions were confident, in fact, that data could be collected rather easily--demographic data and other important kinds of data involving people and uses and effects on people--and that in fact, with study, of course, these can be quantified in such a way as to become useful factors involved in modifying the maximum sustainable yield by social considerations.

I think it's fair to say--and I don't believe I'm wrong in saying it--that both the people who spoke to the question of economics, as well as the social factors, were more confident of their ability to provide some quantitative estimates of these parameters than were the biologists, in discerning maximum sustainable yield. Now, it may be, of course, that this is a selling job. If it is, it was a good one as far as I am concerned.

We talked, as well we should, on the question of the deficiencies of the data and the way of collecting better data both from the standpoint of the commercial uses of a living resource, but also of the recreational uses. We talked about the applications of these in very appropriate ways, in systems and in schemes and models--the need for getting adequate data before we could come up with quantitative measures which would all be applied to an appropriate model in the end which would give us an optimum yield.

I thought these discussions were helpful. I look at them in the context of our discussions here as perhaps the first of a series of discussions that are needed. Perhaps the next time around we can pinpoint more specifically the kinds of data, perhaps more specifically the resources, and later specific areas where these data are needed.

There was a discussion of the political considerations--there was no clear distinction made between these and the social statistics required for social factor input that would go into our formula. But, there were some discussions of the need and desirability and advantages of involving the public in the very broad matter of getting away, essentially, from what one person described as "power politics," and looking at the very broad political process, and the advantages given us by the FCMA in using local community input and local political processes.

There was also a recognition of the growing importance, under the law, of adequate consideration for recreational fisheries. I noted in the summary of the technical group that the recreational fisheries may be winners, or losers. But, as I look at the past fifty years of administering marine recreational and commercial fisheries, it seems to me that the Fishery Conservation and Management Act makes the recreational fisheries a clear winner, a clear winner on almost all counts. I once again would appreciate consideration of that.

Of course, the implementation and administration of this law must be according to the provisions of the Act itself. If the law is implemented, as appears to be happening, as required by provisions of the law and the history, then I think I have to conclude that recreational fishermen are, above perhaps any other user group, clear winners on the basis of the new law.

There was a recognition of new opportunities for multi-disciplinary approaches to our problems. Some of us would say interdisciplinary. We are involving some different disciplines in fisheries management, and some different thought processes. And I can only say from my own experience in my present position at the University of Washington, that this is a very stimulating and exciting experience. Although, oftentimes I can't understand the language that is being spoken by some of these other disciplines. They didn't speak English as biologists do.

There also was some thoughtful discussion in the technical committees, technical groups here at the workshop, for the needs for adequate communication to the Councils. Here, we members of Councils do have something to contribute. We have a lot more experience in dealing with people. We have experience in business, in dealing with political processes, to a far greater degree than the specialists in economics or biology. And it does seem to me from looking at the input from our technical people that we have a responsibility to develop lines of communication with our technical advisors that will improve the communications and understanding on one hand, and the understanding by the Councils of the alternatives and the advantages and disadvantages of each of these alternatives so that we can make a decision when a decision is required.

But, on the other hand, we have got to lead the way in communicating adequately what kind of policies we favor and in what directions we want to go. This is going to help immensely the task of the technical people.

In Scientific and Statistical Committees in the North Pacific Council, the technical people come back to the Council and say, "Well, you know, we don't know what you want. What is it you want?"

I don't think that the Councils yet have faced up to the question of adequately communicating to their right arm, their Scientific and Statistical Committees, the directions and the policies that they wish to follow.

Now, those directions and policies, you keep in mind, are constrained by the law: the legal interpretations of the law, and the political interpretation, presentation, and the guidelines of the law. And it is up to the Councils to understand these and to give guidance. And we are not going to get useful results from these technical people--and God knows we can't do it ourselves because we are all part-timers in the business. What we are going to have to do is to adequately communicate.

I just want to mention some of the general things that were mentioned, and perhaps elaborate on some of these general conclusions that I have raised.

There is no question but what in our discussions we talked about the variability and the reasonableness of varying the importance of these various user parameters--social, economic, biological parameters--between the fisheries and among the Councils. There is certainly adequate justification for this. But, I was struck again this morning by the discussion of the lawyer from NOAA, who pointed out that in drafting the fishery management plans, obviously some rationale must be provided for varying the weight being given to any of these factors. There obviously has to be some justification or the Secretary is powerless to accept our plans. In fact, the Secretary would certainly be negligent if the plans were accepted without having adequate justification.

I was also struck by the statement made by a distinguished executive director of one of the Councils who put the definition of optimum yield very succinctly, I thought, by saying that optimum yield is in fact the sharing of limited resources among user groups.

It was a rather thoughtful and clear, simple definition because in my judgment that is precisely what, if we have learned anything at this particular session, we have learned well.

I think we are all agreed, from our discussions both yesterday and today centering around the question of legal factors and problems, that there is a need for some scholarly legal work. It is the kind of thing that a number of our legal scholars are beginning to produce--people like Gary Knight and Bill Burke and others. I single those out because they are pretty close to me. Some of their work has been, I think, important and has developed some very important new lines of thought.

This study of the Act and its implementation, and the determination of what these very broad, complex, sophisticated definitions and terms in the Act mean is going to be very, very important indeed. So, I look at the legal scholars as another source of special technical talent that needs to be further elaborated and further defined.

Our discussion this morning was quite clear. It emphasized the need for clear understanding and for some additional study. I would hope that some of the excellent young talent, such as we saw this morning discussing this problem with us, I hope that some of the young talent in government would be given an opportunity by their superiors to give some thought and study to this. Unfortunately, these young people in government more often than not, like older people in government, are caught up in the race to accomplish today what should have been done yesterday and don't have time to sit down thoroughly and think about and develop these concepts in a way which will be thoughtful and useful. But, we have got the talent. And they have got the understanding. And I believe that legal scholars can contribute very substantially. That also has been a clear plus from this conference. I think that particular point has been made very, very clear.

The discussions about recreational fishing were, I thought, excellent and followed my interpretation of the law quite well. The point was made that food and recreation are what amount to co-equals in the Act. One might question whether that is an equal balance in fact. But, one can't overlook the clear fact that recreational fishing is given a very prominent role in the Act itself, and is a complicating feature and factor in determining optimum yield.

Without question, populations held at optimum levels so as to produce a high yield from the recreational fisheries will in total yield less than if they were going to be exploited only by those using more efficient fishing gear. Granted, these recreational fishermen may in fact catch more fish than commercial fishermen. But, nevertheless, in order to yield what appear to be reasonable shares in those stocks which are jointly used by recreational people and commercial fishermen, the stocks themselves are going to have to be kept at a high level. This will be a difficult question, to provide such a balance. Once again, it is a question of sharing.

That's the question that Spencer Apollonio made in his simple definition of optimum yield. Nowhere in our discussion did it become more clear than in the discussion of recreational fisheries.

I think the consensus on the question of data collection and data analysis was quite briefly and well put by Don Bevan, who pointed out that the data collection and data analysis problem was an interative process. That is to say, this is a process which must continue, must be one that we continue to give a great deal of attention to, and one that we must continue to discuss amongst ourselves.

Some people have the view that the social and economic benefits would probably be the fallout of a good resource conservation program. Some felt that perhaps we might not need to give quite so much specific attention to the social and economic factors if we, in fact, put a good practical common-sense conservation progam into being. That is a position which I would really question. I would conclude, from our discussions here, that we are better off to attempt to define more clearly these particular parameters and to then make a decision as to what weight we want to give them in deciding optimum yield.

I am suppose to provide a bottom line for this workshop. I don't think I have adequately done that yet. But, I can give you my impression as I leave this conference. I leave it with a greater confidence in our collective ability to successfully implement the Fishery Conservation and Management Act of 1976.

I see this conference as having been a very, very successful one. I think our co-chairmen must be congratulated and must take a great deal of credit for their initiative in putting this together in such a thoughtful and useful way.

I believe there is a consensus among us that this Act, this new law, is a positive step towards better fishery management. And I do not detect, although you may feel it--I do not detect any serious criticisms of the concept of the law and the objectives and the principles that are set forward in the law. I believe there was a consensus that the optimum yield was complicated and that we really haven't yet put together these various parts of optimum yield. It is quite obvious that we have not.

I think that most of us look at this particular conference as an important step. This is a step in defining these particular factors which must be put together into some common-sense statistic which can be used by the Councils in coming up with their fishery management programs, and a step towards providing the Secretary quidelines by which the merits of such plans that are produced by the Councils themselves can be judged.

It seems to me that everybody indicated that they did have confidence that these factors could be used and could be found, could be developed, could be quantified, and could be put together.

The technical people, I thought, felt that the tools, the science, the theories were available, and that they simply needed to be adequately applied, after getting clear instructions, or clearer directions, from the Councils themselves.

It appeared to me from the discussions that optimum yield will quite clearly be a level of yield less than the maximum biological yield. It will be a conservative level of catch that will be applied to the living resource off our coast. This in itself will give society reassurance of the fact that the resource will be perpetuated for the future.

A large number of very important questions were raised. And those were elaborated in the summaries that will be available to you from this particular conference. They do need further elaboration.

In final summary, I would say that the conference, in being successful, did sharpen the issues a great deal. It did tend to begin to provide a common basis for those of us in the various Councils to begin deliberations on these particular issues. The conference has raised important questions. Many of them, most of them, maybe all of them are not completely resolved. But, they brought us together in a thoughtful and positive atmosphere with scientists, government offical, administrators, and Council members from the public so that we have been able to talk in a common language with clear and appropriate understanding. I believe they have pointed directions, at least to me. I am going back to my Council with a clearer understanding of what I need to do as a Council member. However, there remain a very large number of very important matters to be considered. And I make some very simple recommendations as a result of looking at and thinking about and participating in these discussions the past several days.

I recommend that the material that we have produced, including some of the thoughtful discussions, be put together and be circulated perhaps in some kind of cover form. And that these be made available both to our technical committees and to the Councils themselves, and, in fact, that enough copies be made so that the interested public who were not able to be here and might not be members of committees or Councils could in fact have an opportunity to study these results.

I recommend that the questions and issues that have been raised be screened and that another session of this kind be held, one that perhaps could focus more sharply on certain of the important issues, and that it be held sometime within the next year.

Thirdly, I do again want to indicate that I believe that I share with everybody in this room the view that the sponsors of the conference and our chairmen are to be complimented not only for the program that they have put on during the past week, but for the attitudes, the opportunity for a change of point of view. The representation that has been invited and has participated in this conference, it seems to me, simply could not have been better. And I believe in my own mind that I leave this conference with a much better understanding of the law, the particular issues to be resolved, and the tasks that lie before us as a nation.

III Papers from the Technical Session

Each of the people who presented papers in the technical session of the workshop was invited to submit a paper for inclusion in this report. Unfortunately, not all those present at the workshop were able to submit a written version of their presentation. For certain of the speakers we have included the edited text of their verbal presentation. For others, however, due primarily to extensive references to charts and figures, this substitution was not possible.

We have attempted to tie the papers together by providing a short editorial comment on each one. In the case of those who could not submit papers, we hope that these comments in combination with the abstract of their talk will adequately represent the basic substance of their presentation.

One of the most difficult assessments to make regarding systems as complex as fisheries systems is that of their 'efficiency'. Although the concept of efficiency is one which has an intuitive meaning for most of us, the exact nature of what constitutes efficient behavior or management is problematic. Even after we agree on the factors which must be considered to assess the efficiency of a system, the problem of the measurement of those factors remains.

Lee Anderson argues in the following paper that these measurements can and should be made, and that the study of welfare economics provides a framework for this task. His point of view is that the tools of economics are sufficiently developed to allow us to institutionalize maximum economic yield (MEY) as a necessary adjunct to our biological yield concepts in working towards optimality.

OPTIMUM YIELD: THE LAW, ECONOMIC THEORY

AND PRACTICAL APPLICATION

Lee G. Anderson
Associate Professor of Economics & Marine Studies
College of Marine Studies
University of Delaware

Part of this paper is drawn from material presented at a Conference on Marine Economics and Marketing Research in the Great Lakes, Michigan State University, March 23-25, 1977.

This paper was written for the technical session of this workshop on optimal yield, and when I was asked to prepare it, it was stressed that the organizers were looking for technical discussions of the subject from different fields. Therefore I feel justified in the somewhat technical presentation I plan to make. It is not that I plan to talk about anything wonderous, mysterious, or really that difficult. Rather I will be going into some of the technical aspects of economics that are often left unmentioned in discussions of fisheries economics.

What I plan to do is to give a brief description of basic welfare economics, give a definition of pure economic efficiency and show how it is related to the concept of maximum economic yield. Finally I will discuss how I think that MEY can be related to the spirit and the letter of the Fishery Conservation and Management Act.

Although the first part of my presentation will be somewhat technical for the non-economist, I think it will be quite useful. When we are talking about fisheries management, especially with regard to the concept of optimum yield as specified by the law, we are really talking about reallocating resources so as improve the net benefits derived. And this is precisely the topic with which theoretical welfare economics deals. There may be some fundamental disagreement with the basic assumptions used, and admittedly there are some difficult problems in translating the conclusions to practical policy, but I still believe that some very useful insights can be gained.

Before I get started I want to make one point. I do not want to dig up old battles between economists and biologists, or economists and anybody else for that matter. These non-productive quarrels have been long buried and I think we are so much the better for it. What I am trying to do is to describe how an economist looks at the problem of determining an optimal yield, with the hope, but also with some confidence, that the solution will be easier with the insights offered. The first part of my paper is not meant to be a proselytizing effort. It is meant to be purely descriptive. I want to make clear precisely what an economist means when he talks about economic efficiency. I think there has been some misunderstandings on this point in the past (and I'm quite sure some still exists among current council members) and this misunderstanding has hindered proper communication. I would like to say right at the start that I do not believe that pure economic efficiency should necessarily be the only criteria in determining optimal yield. But I definitely do think that it must be considered and I will suggest a way that it can be used as a ground zero point in determining it. So while the first part of my paper will describe what pure economic efficiency is, the second part will show how this concept can be used.

Before we can ask how an economist would approach the problem of finding an optimum yield, we must ask what the science of economics is.

As individuals, families, and nations, we are all faced with the same problem. We have essentially unlimited wants relative to our capacity to fulfill them. One very big part of economics is the study of the allocation of resources so as to maximize welfare.

But what is welfare? And how can we tell if it is improved? Welfare economics answers these questions in the following way. We can measure welfare by the value of the goods and services produced. This must include all types however. For example, a recreational fishery provides services even though they are not bought or sold. A reallocation of the basic resources of society that results in an increase in the value of the goods and services produced is an improvement in welfare. To be precise we must say that such a reallocation has the potential for bringing an unambiguous improvement in welfare, because there may be some redistribution of income such that even with a larger value of total output, some individuals are actually worse off.

Put in a static general equilibrium basis, an optimum welfare level will be achieved by maximizing the value of the consumption bundle given the state of technology and the existing amount of resources. Formally, this is

$$\text{Max} \sum_{i=1}^{n} \int_{X_{i_o}}^{X_i^*} P_i(X_i)$$

$$\text{s.t.} \quad (F(X_1, X_2, \ldots X_n, a_1, a_2, \ldots a_n),$$

where the P_i functions are the demand curves for each of the n goods and services produced, and the a_i's are the given amount of basic resources. Essentially, this says that the vector of outputs $[X_1^*, X_2^*, \ldots X_n^*]$ that solves this constrained problem will be the one that achieves the highest sum of the areas under the demand curves of the outputs. (If we are to be precise with regard to intertemporal use of resources, the proper maximand would be the present value of the consumption bundles through time. Since we are more concerned with another issue, we will stick with this simpler model.)

The mathematics of this problem is simple, at least conceptually. The real problem is in trying to place a proper interpretation on the solution. There are several related points that are important at this juncture. First, the set of outputs under consideration must include all possible goods and services, not just those that are produced in a market. The value that is generated by using a beach area to produce a pleasant walk at sunset or a fish stock to produce recreational services should be included just as much as the value produced by using several tons of steel to produce an automobile. If we all can agree that market and nonmarket goods and services should be included, then I am quite sure that there will be general agreement on the basic economic problem of society, that of choosing the proper combination of final goods and services given a limited amount of basic resources.

It will be less easy to get general agreement on choosing the proper weights to place relative values on each of the goods and services. As set up here, the demand curves serve this function. There are two basic objections to this use. Some individuals think that people really do not know what is good for them and would argue for some socially determined weights. In addition, it is often stressed that demand curves are partially determined by the distribution of income and therefore a different distribution of income will yield a different optimizing bundle of outputs. There is not sufficient time to go into the arguments that have centered around these topics. Suffice it to say that both points have their merits, but for basic economic analysis, most economists have accepted the value judgements that individuals are the best judges of their satisfaction and that the existing distribution of income can be accepted as a basis for economic analysis. These underlying value judgments should be kept in mind whenever policy recommendations are derived from the theory, however.

A final point is that we certainly do not have demand curves for many non-market goods and services; in fact, it might be said that for some of them we have absolutely no notion of how to go about deriving them. With regard to recreational fisheries we have come a long way in this regard. Nevertheless, a proper conceptualization of the problem even if it cannot be used in all cases at present, is in my opinion, far better than an incorrect notion amenable to measurement.

It is this basic model that lies behind the concept of maximum economic yield. Because I think it is a familiar concept, I will just review it briefly. Due to the nature of the property rights to fish stocks, the tradegy of the commons causes biological overexpolitation. And in order to achieve the overexploitation (if achieve is the proper word to use in this context) labor, capital, and other variable inputs, must be used to produce fishing effort when they could be more properly used elsewhere. That is, by reallocating resources from that combination that exists at open-access, it is possible to increase the value of goods and services produced thus affording the potential for an increase in the welfare of society.

This point is so important that it is worth repeating. One of the reasons that economists got interested in fisheries in the first place was the fact that if left unregulated, an economically inefficient allocation of resources will result. And from a pure economic efficiency point of view, the goal of regulation should be to cause a reallocation of resources such that the particular bundle of goods and services that has the highest value is produced.

This model also provides a very firm basis for determining an optimal yield from a fishery. I say basis because even a casual reading of the law demonstrates that other considerations must be taken into account. We must consider income distribution and other social and ecological factors. And the law notwithstanding, I think there are reasons why other things should be considered. But as an economist I feel I have an obligation to make sure that decision makers are aware of the concept of economic efficiency and argue that it should be at least given some consideration in the decision making process. In fact, I will go a step further and say we should provide information on the trade offs between economic efficiency and each of the other criteria that are important to decision makers.

I contend that a good way to help define optimum yield in the various fisheries is to devise models that can demonstrate at what point an open-access fishery should be operated in order to achieve a maximum economic yield. The model should be devised in such a way, however, that measurements concerning other important variables are obtained simultaneously. Therefore, the description of MEY should include the amount and kind of effort that should be used, the amount of the economic rent, and other parameters for such things as income distribution among fishermen, the general profit level in the harvesting and processing sections, the number of possible recreational days fished and an accompanying probability of success rate, and other measures of sociological and environmental impacts. Then by studying how this vector of parameters varies as regulations other than those that will achieve MEY are used, decision makers will be able to study the trade offs involved. This should help them in defining what they believe the optimum yield to be.

As an example, consider a two dimensional case where the vector of parameters includes the amount of rent earned and the number of otherwise structurally unemployed individuals that are working in the fishery. If the vector at MEY is ($100, 18 people) but by using a specific entry program designed to help the structurally unemployed it changes to ($50, 38 people) then the price in terms of lost efficiency of putting the extra 20 people to work is $50.

Several interrelated points are in order here. Although I admit that the number of structurally unemployed people used in a fishery may be an important consideration, regulation schemes which only consider them are very likely to be socially sub-optimal. That is, unless there is some absolute necessity for reducing the number of structurally unemployed people to zero, when faced when a range of regulation options and using only the number of these types of people employed as a judgment criteria can the decision maker be sure that the one he chooses will be the best policy? The answer is no because he does not know what he is giving up. Obtaining redistribution goals may not be worthwhile if the loss of valuable output is too high.

One might accept the above point about trade offs without accepting MEY as a benchmark. Why not just test all possible policies and then compare the vector of parameters for each and select the one that appears the best. It is possible of course to make statements about the relative desirability of different policies, but the lack of an absolute standard leaves something to be desired. In addition, it is a backward way of going about fisheries management. It would be almost impossible to list and test all of the possible ways of managing a certain fishery. And even if it were possible, it would be very difficult for the decision makers to compare each with every other. By starting at the economically efficient point, the decision makers can request information on which policies will change a variable with which they are particularly concerned and then see if the change they want is worth the price that must be paid.

The last point with regard to comparisons of these vectors is for the benefit of the strict interpretationist economist who wonders about all this concern for non-efficiency objectives, especially distribution. In most other fields of economics, efficiency plays the central role and points about distribution are usually left for small footnotes. Why so much emphasis on them in fisheries economics? The reason for this is that when we are talking about reallocations of resources to correct for common property, redistributions of income are part and parcel of the change and cannot be logically ignored. Almost be definition, regulation of an open-access fishery implies changing the structure of the relevant property rights. Some will win and some will lose by this change. It simply does not make sense to ignore the distribution effects in these instances.

There are several models being built at the present that can do the type of analysis described above. With support from the National Science Foundation, I am building one for the interdependent fisheries in the Northwest Atlantic. A description of it may be found in Agnello and Anderson (1977).

References.

Agnello, R. J., and L. G. Anderson. 1977 "Production Relationships Among Interrelated Fisheries." In Economic Impacts of Extended Fisheries Jurisdiction, ed. L. G. Anderson. Ann Arbor: Ann Arbor Science Publishers, Inc.

Any modeling approach to the analysis of fisheries must clearly set out the assumptions the researcher is making about costs, prices, weather, maintenance time, and variables which are more difficult to describe such as the relationships between harvestors and processors. Using a simulation model for an existing fishery in combination with a data analysis which produces hypothetical catch rates based on certain of these assumptions, the Bledsoe, Mesmer, and Katz paper analyses the potentials for a particular class of fishing vessel in a domestic Alaska pollock fishery.

As the paper point out, once a model is developed it must be calibrated, or parameterized so that it correctly 'hindcasts' past catches. This does not ensure that it can correctly forecast. It does, however, tell us that even if we cannot explain exactly why the system works as it does, we can at least use models to help us describe what is happening in the system with some degree of percision.

Pragmatic Approaches to Fishery Management for Optimum Yield:
Determination of Supply Curve for a Domestic Alaska Pollock Fishery

L. J. Bledsoe, K. Mesmer, P. Katz
July, 1977

Summary of a paper given orally at Optimum Yield Workshop,
National Marine Fisheries Service, Houston, Texas,
June 6 - June 10, 1977

Two approaches to determination of a relation between price paid to the fisherman and value of catch produced for a hypothetical domestic Alaska Pollock fishery in the E. Bering Sea are presented. One approach is based on a large-scale simulation of the existing shellfisheries which would, supposedly, share vessels and gear with the Pollock fishery; the second approach involves a data analysis of costs of trawling, value of harvest, percent of utilization of existing capacity and projected catch rates for Pollock. The model based approach is incomplete but has proceeded to the point of verification of the method by hindcasting the 1974 shellfish catch in western Alaskan waters. The data analysis approach reveals that, based on variable costs of fishing alone, and assuming an ex-vessel price of .10/lb, 55,900 mt of Pollock could have been harvested in 1974 at a net value to fishermen of $10.1 million dollars. This estimate is based on the critical assumption that 60 days of non-fishing time (maintenance, vacation, preparation, etc.) is a reasonable figure for the average requirement of <u>all</u> combination vessels which fished western or Kodiak region Alaskan waters in 1974.

The model based approach operates by consideration of catch rates for a variety of shellfish and groundfish stocks described in Table 1, which were or might have been harvested in 1974 at prices extant that year. Detailed population dynamics sub-models for these stocks are considered. Registered western Alaska fishing vessels greater than 40 feet in length are divided into over 20 fleets, each consisting of several vessels in one of 15 vessel classes, which are described in Table 2. The model assumes that each fleet will choose a fishery which will maximize its short term net economic yield. This choice is subject to constraints of gear and weather capability, area-species regulations and existing processing capacity including contractual obligations between skippers and processors.

The results of the model are a prediction of catch, in net economic and biological units, broken down by time, area, stock and fleet. Analysis of the model is done by repeated simulations with different assumptions concerning variables of strategic interest, especially those whose exact value is uncertain (e.g., CPUE, price of the hypothetically fished stock, location and capacity of new processing plants, times of opening and closure of intensively fished stocks, gear-area regulations, etc.). Prior to investigation of a hypothetical new fishery the model must be parametrized or calibrated in such a way that it correctly hindcasts past catch distribution of existing fisheries. This calibration is now being carried out; no insuperable difficulties have been encountered or are anticipated. The strategy is to determine an appropriate level of aggregation of the fleets and the degree to which processing capacity and/or processor-skipper contractual arrangements may have limited king crab and shrimp catch levels in 1974.

The data analysis approach, considered an essential complement to the model based approach, consists of the following development. Pollock CPUE in 1974 for a chartered survey vessel ranged between 2400 and 5100 lb/hour trawled. This translates to a range of 10.9 to 36.2 mt/day catch assuming 10-14 hours per day trawling. Class 8 combination vessels, which are generally capable of otter trawling, have hold capacities for Pollock of 50-80 mt indicating that 1.4 to 7.3 days of trawling will be required for a full load. Variable costs of Pollock fishing trips by trip length for class 8 vessels are given in Table 3. Assuming that 1/2 day average trawl time from a Dutch Harbor port to the Bering Sea fishing grounds is adequate and considering that Pollock quality deteriorates substantially after 3 days on ice, a fishing trip of 4 days for a 50 mt load and a 1 week trip unit including port time, seems a reasonable overall average. This ignores a number of technological possibilities including both pair-trawling and extensive installation of freezing facilities.

Table 4 indicates the values of a full hold of Pollock for class 8 vessels at various ex-vessel prices. A comparison of these conclusions, costs of vessel operation, relative catchabilities and hold capacities for Pollock and king crab will reveal that a price per pound of about $.30 for Pollock would be required to induce fishermen to switch from Bering Sea King crab at $.42/lb (ignoring gear costs). Since realistic Pollock prices are closer to $.10 per pound (Jan. 1977, Seattle, $.08/lb) a Pollock fishery can only develop when no opportunity to fish for more highly valued species exists, i.e., when some harvesting capacity excess to the present fishery exists.

To provide some information as to whether such excess capacity exists, an analysis of the landing record of each vessel capable of hauling an otter trawl, and which also participated in W. Alaskan shellfisheries in 1974, was undertaken. Landings of class 8.3 vessels are shown in Figure 1. This analysis revealed that 95% of the time intervals between landings were 2 weeks or less. Using this statistic and the critical assumption that 60 days of non-fishing time is sufficient, 1118 one week unit trips could be made by the 146 class 8 combination vessels alone.

Class 8 vessels, modern steel combination boats, alone were analyzed because these vessels are of sufficient horsepower and size to harvest Pollock via otter trawl. Their effort would harvest 55,900 mt of Pollock with a gross ex-vessel value of $12.3 million, net value (approx. $2000 per trip direct costs) $10.1 million. These estimates ignore fixed gear costs and do not allow for gear loss. If the non-fishing time requirement is 120 days average, only 2150 mt could have been harvested. The break even price for Pollock harvest under the above assumptions is .02/lb., again considering variable costs only.

Based on the above assumptions and considering the known limitations of the procedures described we can tentatively project two points on a short term supply curve in 1974 for a domestic Pollock fishery, shown in Figure 2. These data points also assume that $10.1 million net value is sufficient incentive to attract all of the combination boat skippers to spend their excess time fishing for Pollock, and to layout the fixed expenditures required.

TABLE 1

STOCK ATTRIBUTE INPUT VALUES 1974-75 SEASON

Stock	U.S. Catch (10^6 lbs)	Est. Stock Size (10^6 lbs)	Est. CPUE*	No. Vessels	Guideline Harvest Level (10^6 lbs)
Kodiak King Crab	23.6	70**	214 LB/PL	116 > 40' 158 total	20
Kodiak Shrimp	58.2	120**	2890 LB/HR - S 4050 LB/HR - D 1550 LB/HR - B	29 28 17	55
Bering Sea Pollock (IPHC Area A)	--	5290	4300 LB/HR - D 3050 LB/HR - S	-- --	none
Bering Sea Pollock (IPHC Area C)	--		4300 LB/HR - D 3050 LB/HR - S	-- --	none
Bering Sea Red King Crab	42.3	115	199 LB/PL	104	41
Kodiak Tanner Crab	13.6	50**	185 LB/PL	97 > 40' 123 total	none
Unalaska King Crab	14.0	50**	195 LB/PL	87	14.5
Bering Sea Blue King Crab	7.1	21**	155 LB/PL	19	none
S. Peninsula Shrimp	48.3	110**	2032 LB/HR	49	none

*Units of effort: S - single otter trawl D - double otter trawl
B - beam trawl PL - pot lifts

**Preliminary estimate based on insufficient data

TABLE 2
1974 WESTERN ALASKA SHELLFISH VESSEL CHARACTERISTICS

Class	Description	No. of Registered Vessels	Ave. Keel Length (ft)	Ave. Net Tonnage	Ave. Engine Horsepower	Ave. Hold Capacity (ft^3)
1.0	all vessels < 40'	198	32.6	11.1	159.6	406.9
2.0	all vessels 40-45'	37	41.8	19.4	194.5	590.0
3.0	older limit seiners	24	48.3	29.5	216.2	1035.7
4.0	modern limit seiners	25	49.3	41.2	343.3	1625.0
5.0	halibut schooner	2	51.0	26.0	265.0	1000.0*
6.1	power scow	4	51.0	24.6	288.8	1000.0*
6.2	power scow	15	86.4	147.9	438.3	4375.0
7.0	small crabber	18	54.1	39.4	259.3	1250.0
8.1	combination	18	66.8	71.8	413.1	3083.3
8.2	combination	65	76.9	110.3	524.3	3522.7
8.3	combination	29	86.0	128.2	668.1	5350.0
8.4	combination	23	94.2	147.5	908.4	7500.0**
8.5	combination	11	108.3	137.6	1005.0	9500.0**
9.1	converted seiner	28	64.1	49.2	270.8	1836.4
9.2	converted seiner	28	75.8	70.5	394.3	2704.5
9.3	converted seiner	8	91.1	115.3	503.1	4750.0
10.1	converted military	10	70.6	81.4	354.5	1040.3
10.2	converted military	16	137.3	228.5	948.2	8250.0
	unknown	16				

*estimated by Katz et al., 1976.
**according to specifications of Marco, Inc.

TABLE 3
VARIABLE COSTS OF FISHING TRIPS FOR POLLOCK
BY TRIP LENGTH AND VESSEL CLASS
(Dollars)

Length of Trip (Days)	Vessel Class 8.1	8.2	8.3	8.4	8.5
3	1194	1411	1541	1428	2289
4	1650	1951	2131	2252	3170
5	2106	2491	2720	2876	4050
6	2562	3031	3310	3500	4931
7	3018	3571	3900	4124	5812

TABLE 4
VALUE OF FULL HOLD OF POLLOCK AND KING CRAB
BY PRICE PER POUND AND VESSEL CLASS
(Thousands of Dollars)

Price per Pound ($)	8.1	8.2	8.3	8.4	8.5
			Pollock		
.05	3.7	3.7	5.2	4.2	5.9
.10	7.6	7.4	10.4	8.4	11.8
.20	15.1	14.7	20.7	16.8	23.6
.30	22.7	22.1	31.1	25.3	35.4
.50	37.8	36.8	51.9	42.1	59.0
			King Crab		
.42	22.7	22.1	31.1	25.3	35.4

Figure 1. Landing Record of Class 8.3 Vessels in 1974
Indicating Amount of Excess Capacity

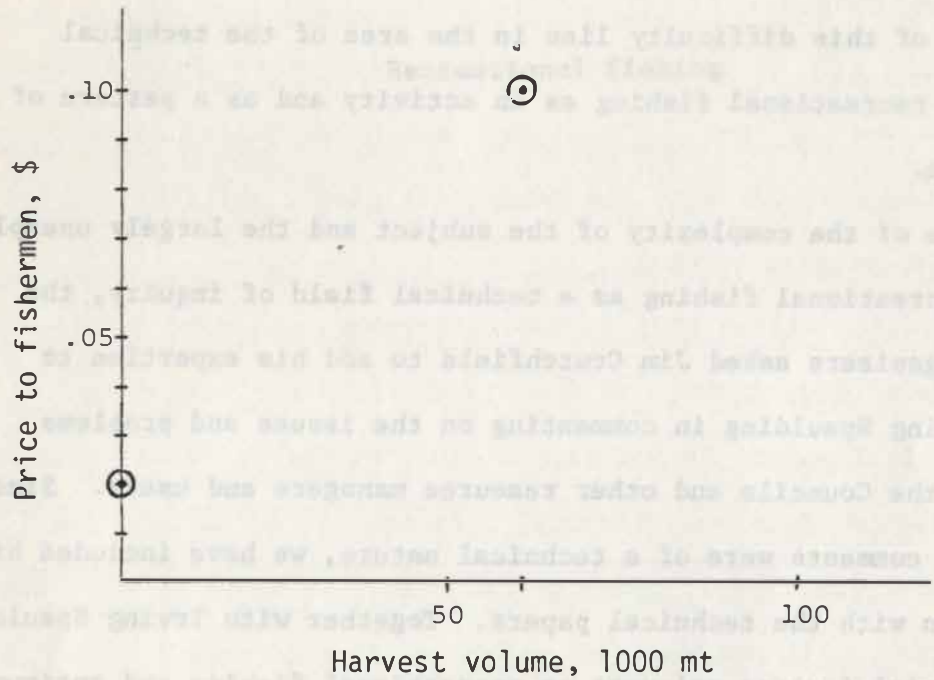


Figure 2. Short Term Supply Curve for a Hypothetical Domestic Trawl Fishery, 1974

Recreational fishing is one of the most difficult areas to integrate into fishery management plans with respect to optimum yield, capacity, or any of the other concepts with which those documents must deal. Much of this difficulty lies in the area of the technical anaylsis of recreational fishing as an activity and as a pattern of resource use.

Because of the complexity of the subject and the largely unexplored state of recreational fishing as a technical field of inquiry, the workshop organizers asked Jim Crutchfield to add his expertise to that of Irving Spaulding in commenting on the issues and problems which face the Councils and other resource managers and users. Since many of his comments were of a technical nature, we have included his presentation with the technical papers. Together with Irving Spaulding's paper on social factors relevant to recreational fishing and optimum yield, this presentation provided a background for Richard Stroud's discussion of Recreational Aspects of OY in the Council session.

Recreational Fishing

James A. Crutchfield
Department of Economics
University of Washington

Presentation made to the Optimum Yield Workshop
Houston, Texas, June 6, 1977

Recreational fishing represents a very significant user group. I am struggling, and I suspect many of you are struggling, with the inadequacy of both concept and measurement of recreational fishing, and with trying to fit these activities into the concept of optimum yield.

I would like to raise some technical questions about recreational fishing in the way that I think they have to be raised if they are to be fitted properly into the management plans, and then suggest some tentative conclusions.

One of the things that is most important, and most difficult to get across to many members of Council who have not worked in recreational fishing, is the significance of the different units of output which recreational fishing produces. It is obviously a recreational experience, commonly calculated in terms of user days, and not fish. All one needs to point out is that some of the most spectacular recreational fishing is for fish that probably taste like a ball of cotton filled with darning needles and are not particularly useful as food.

What is significant is the function that relates angler success, catch per fisherman day, to the position and shape of the demand function for the recreational experience. There is no simple, ready way to translate a demand for recreational fishing, as an output, into numbers or weight of fish per se. Yet, somehow that translation has to be made in the course of producing a management plan.

It follows from that the equally obvious fact that a fish population managed to maximize the output of the fishing experience for recreation would have very different size and probably a different age composition than a population managed to produce the largest net economic benefit for commercial utilization--typically a much larger population and frequently a population composed of larger specimens in cases where trophy fishing is of major significance.

So, it isn't just a question of allocating given numbers from a given aggregate. The aggregate population will be significantly different, depending on the weight of the recreational versus commercial components. All of you, I am sure, can think of an example, and a good example is the salmon fishery, where management for the optimum recreational contribution would clearly result in a lot of spawners going upstream and remaining unutilized.

The third point I want to make is that I feel, having run some of these things that are techniques for finding artificial demand functions for outdoor recreation in general, and sport fishing in particular, that they are not particularly satisfactory, and produce numbers that frequently change after a few years.

The gross expenditure approach is, I think, quite useless in meeting the requirements for management plans for commercial fisheries under the Act of 1976. It may have some usefulness in indicating economic impact in local or regional areas. It is well to have numbers for that purpose. But, to derive a measure of net economic benefit from the recreational fishery that permits direct integration with a competing commercial use involves either of two techniques which have been tried and tried and tried and which, in my opinion, still have yet to produce very usable numbers, despite their theoretical correctness--one, the travel-time model, the other the use of the questionnaires--designed to elicit willingness to sell or willingness to buy, depending on the set of questions you use, the right to the recreational fishing experience.

I won't bother to repeat the difficulties involved. As Tony Scott pointed out better than anyone else, there are very serious conceptual difficulties with the travel time model. It consistently under-estimates the position of the demand function and overestimates its elasticity, both of which lead to an under valuation of recreational fishing. Even if your data were really adequate, the absence of homogeneity of the population sampled in the travel time model, which is implicit and a very important part of the process, creates still further problems.

On the other side, the practical side, it takes three to four years on the average between initiation of a study and publication of the results. By that time, since you are shooting at a moving target, the numbers are likely to have very little value, even if they were a great deal more accurate conceptually than most of them are.

The only alternative is to start turning to user charges for recreational fisheries. In a good many of the Western States the idea is coming to be accepted that recreational users are an identified consumer of a valuable resource, and as such should be willing to pay a price for that use of the resource. At least we get a position on the demand function, if nothing else.

But, it is obvious that it is far from general throughout the country. Even the prices that are charged are more than likely niminal charges. They don't really indicate willingness to pay in a very serious way.

I think there are plenty of opportunities for enhancement of the aggregate benefits from a shared fishery resource by rearranging commercial and recreational fishing activities in time and space.

Salmon fishing, again, is an excellent case in point where much of the friction and a great deal of the really difficult allocation problems could be resolved by placing the salmon sport and commercial fisheries in a different physical relationship to one another. There may be other opportunities, as well, that could be considered.

I am sure all of you are aware that there are interspecies problems which can be serious with respect to the output of recreational fishing services. Our Council faces a most serious problem with respect to the anchovy--at least it may be serious. Nobody has really researched it carefully enough to know. Doubtless there are plenty of species in the Atlantic and Gulf Coast where commercial harvest of forage fish has impacts on recreational fishing which ought to be included in one or more of the management plans.

Finally, I reinforce again the need that the anthropologists such as Susan Peterson have emphasized, for knowing who the sport fishermen are and of their social-economic characteristics, if for no other reason than to reflect the fact that quantity, quality, and accesibility of recreational fishing may be viewed very differently by different income groups and different regional groups. I venture the opinion that most recreational fishing tends to be dominated by upper middle class and an upper income elitist attitude towards quality, which may give us much too much emphasis on limited high quality recreational fishing, and not nearly enough emphasis on different quality, but much more readily accessible types. We don't tend to think in these terms if we are really true, born in the blood, recreational fishermen. But, they are a very important part of the allocation process.

These, I think, are some of the problems All of us are going to face these problems in integrating recreational fishermen and commercial fishing, for the simple reason that if we don't, we will be in Court very quickly. Recreational fishermen are that well organized.

Systems modelers can use many different analytical tools in their work. Each of these different tools may yield a somewhat different 'fit' between the model and the data which it is attempting to analyse.

In his work with the Georges Bank groundfish stocks, Jack Devanney uses a particular technique, Bayesian regression analysis, to address the recruitment relationship in these stocks in light of our uncertainty as to the exact nature of this relationship. Techniques such as this allow us to approximate a sequence of events or relationships in the absence of sufficient data to make exact assessments.

Findings from analyses of this sort can often point out situations which are subtle and counter-intuitive. One such finding in Devanney's work is, in the case of yellowtail flounder, that there is a possibility of a double-humped revenue curve. This implies that revenue to the fishermen may be "maximized" at more than one single catch level, and that additional factors aside from revenue will have to be utilized in deciding between different levels of catch in the economic considerations which enter into optimum yield.

One of these additional factors, as Devanney pointed out in his presentation at the workshop, is consumer costs and preferences. These and other points will be addressed when the full results of his studies are published.

J. W. Devanney, III

Associate Professor of Marine Systems

Massachusetts Institute of Technology

Fishermen and Fish Consumer's Income Under the 200-mile Fishing Limit

This paper describes a series of single species models of the principal Georges Bank groundfish stocks. Empirical evidence suggests that, at least at lower levels of landings, demand for these fish can be quite inelastic. Further, at least for yellowtail flounder, the possibility of a double-humped fisherman revenue curve obtains. The paper emphasizes the importance of bringing fish consumer income into the analysis in such situations. The models are dynamic, and results are presented which indicate that these fisheries can be very lightly damped with natural periods of 5-15 years. Hence the applicability of steady state models to the generation of actual management schemes for these fisheries may be very limited. The stock recruitment relationship and our uncertainty as to the form of this relationship is addressed by Bayesian regression, and this approach is outlined in the paper. Finally, results are presented which indicate that for the stocks studied, not only is there no current surplus left by the departure of the foreigners, but also that present levels of domestic effort should be cut back sharply.

The FCMA mandates that ecological factors be taken into account in the determination of optimum yield. Studies in ecology, however, especially in the critical area of inter-species interactions and population dynamics, are still in their developmental stage.

Low Lee Loh's presentation on ecosystem dynamics did a great deal to contribute to an understanding of the role of ecological analysis in optimum yield. Besides providing a model for studies of this kind, Loh's presentation suggested some interesting ideas which resulted from his analysis: that the major loss to the stocks which he studied was due to internal ecosystem consumption rather than fishing mortality, and that many stocks are subject to long-term fluctuations in abundance independent of fishing pressure.

Finding from research of this sort have a multitude of applications and implications. They suggest that we cannot hope to completely describe, much less explain the pattern of events in our fisheries without the use of ecological anslysis. They imply that MSY models may not be very useful as an indicator of long-term abundance, or of the level of fishing pressure which is necessary or desirable to ensure that abundance. They have great import for the study of the relationship between recreational species and both the forage and the predator species with which they interact.

Although Loh's findings are for a particular system in the Eastern Bering Sea, his methods and many of his results may be generalized to other fisheries. The publication of his research will hopefully stimulate this process.

Low Lee Loh
Fishery Research Biologist
Northwest and Alaska Fisheries Center
National Marine Fisheries Service

Ecosystem Dynamic Considerations in Optimum Yield Determination

The derivation of Optimum Yield obviously must start at the resource level itself. At present, the study of most fishery resources in the North Pacific has been approached on a single species basis and brings into consideration multiple species interactions only at an empirical level. As one gains more knowledge of the ecosystem, studies must progress from empirical and traditional population dynamics analyses to include models on species interactions and ecosystem dynamics. A major thrust of such modelling projects at the Northwest and Alaska Fisheries Center (NWAFC) has been on the eastern Bering Sea (EBS) ecosystem which supports extremely valuable resources such as marine mammals, crabs, fish and petroleum.

Dealing with the biological system itself, the NWAFC has initially developed a static-trophic Bulk Biomass Model in order to evaluate biomass balances of important ecological groups in the EBS. This model provides quantitative insight of plausible standing stocks of the ecological groups and insight into ecosystem internal comsumption as compared to losses due to fisheries. Computations show that the greatest part of most of the ecological groups are consumed as food by other ecological groups. The results underline the fact that enhanced evaluation and management of marine resources in the EBS requires consideration of the dynamics of the marine ecosystem as a whole.

In order to consider dynamics of the EBS ecosystem, a Dynamic Numerical Marine Ecosystem (DYNUMES) Model was also formulated. The model, at present, permits evaluation of the interactions of eight representative biological components--fur seal, bearded seal, herring, pollock (3 size groups), shearwaters and murres. Results of the model indicate several phenomena within the ecosystem that have received little attention in the past research, but which seem to be among major determinants of the balance within the system. One of the general conclusions from the use of the model is that availability of food is a limiting factor for most ecological levels and groups. Furthermore, the model indicates that some transient stocks, such as pollock, have long-term periodicities of abundance, caused by interactions of several factors determining their abundance. The use of the submodel also demonstrates that the dynamics of marine ecosystem and man's effect on it can only be ascertained in detail with a rather sophisticated, reasonably complete model.

In his summary talk, Don McKernan expressed disagreement with the statement that sociological factors are just beginning to be considered in fishery management. He quite correctly points to several examples where considerations other than biological ones were the prime determinants in management decisions.

There is no doubt that this is true. Social factors have always been significant if not primary components of the decision-making process. Rarely if ever, however, are these factors and their place in the management process assessed and recorded in a scientific manner.

In this next paper Mike Orbach summarizes some of the items which constitute the social factors in fishery systems, and suggests ways in which a knowledge of these factors can be applied to our management problems and concerns.

Social Science and Fishery Systems

Michael K. Orbach
Social Anthropologist
National Marine Fisheries Service
National Oceanic and Atmospheric Administration

Presentation made to the Optimum Yield Workshop
Houston, Texas, June 6, 1977

This paper is about the essential building blocks of any ocean use system, and also of that brand of science known as 'social' science; people. Although we will address a particular set of human systems--fishery systems--most of the concepts are generalizable to all ocean use systems; shipping, oil and mining, energy, recreation and tourism, and others.

A system is a set of interrelated components. In a fishery system, the primary, most dynamic, but most difficult components of the system to analyse are people and their behaviors.

Most fishery systems, or rather the people whose behaviors comprise the system, are made up of sub-systems. These sub-systems are groups whose participants interact closely, perform similar functions, and share common characteristics. This definition of sub-system, for most fisheries, breaks them down in the following way:

-Harvesters/Users

-Owner/Managers

-Unloaders

-Processors

-People in infrastructural economic concerns

-Other invididuals and organizations in the general public who are affected by the actions of people involved in the fishery

-Consumers

-Distributors

-Scientists

-Resource Managers

-Legislators

The exact nature and structure of these components, or sub-systems will differ for each particular fishery system. In many cases they will overlap or be co-terminous, as in the case of harvester/owners. The point, however, is that the people within each of these components are concerned with a particular set of processes which contribute to the extraction and eventual 'consumption' of a fishery resource. These processes together constitute the fishery system.

In the view we are taking here, <u>people</u> and their behaviors and interactions are the primary components of a fishery system. The range of the system is determined by the frequency and extent of contact among its parts. From this point of view, many of the traditional variables which have been used to analyze fishery systems, for example biology, international affairs, and laws and regulations, are essentially exogenous to the system. They are variables which certainly may have an effect upon the system, but which are not internal to the primary patterns of interactions themselves. This view of fishery systems, which in our opinion is the most neglected and at the same time the most important for an understanding of the workings of a fishery, is based on people rather than on biology, or politics, or economics.

Assume we agree that a people-centered system such as we have proposed is a reasonable way to look at a fishery. In attempting to describe that system, or analyze it, what kinds of things would one look for? What are the units of analysis? What would constitute the raison d'etre for research into such a system? We would suggest that there are three levels' of analysis.

Demography

The first level is that of demographic variables. We are using demography' in the loose sense of countable, unitary variables. In this sense, fishery systems can be outlined using a number of demographic variables.

The first is simple numbers of people. How many people participate in the system? What are the relevant categories of participation? Although there are aggregate figures available concerning the number of people in certain parts of many fishery systems, these figures are in most cases partial and based on cumulative conventional knowledge rather than good basic research. A recent research project carried out at Woods Hole Oceanographic Institution, which actually surveyed the number of fishermen in selected New England ports, found as large as 50 percent discrepancies in the numbers of fishermen from published information. Although we mandate ourselves to consider fish stocks in all of their interactions with other stocks and throughout their ranges, when it comes to considering the people in the fishery system we often seem to be content with fragmented and incomplete or non-existent knowledge.

Borrowing the phrase "throughout their ranges" from the biologists, we are led to the second variable, location. Once we know how many people there are in the system and what they do, we should know where they live and where they work.

Where are the home ports of the fishermen of the West coast combination-rig fleet who travel up and down the coast using different rigs to fish albacore, salmon, crab, and other species? Where do they pick up their crews? Where do they have their maintenance done? To the economies of which coastal communities do they lend their business? We could ask the same questions of the surf clam fleet on the East coast.

As another example, the menhaden crews in the Gulf of Mexico and on the Atlantic coast are involved in a specialized, seasonal fishery. Where do they live? Where are the schools which educate their children? What do they do in the off-season? How many of them migrate back and forth between the Atlantic and the Gulf? If they do migrate, do they take their families? Where should we look to attempt to assess the effects of any change in the fishery on their lives and their communities? What is the 'human geography' of that fishery system?

A third demographic variable is the age structure of the fishery participants. Is it a 'young' fishery, with the boats manned by men and women at the beginning of their careers? Is it a fishery of older men and women, one which stands a chance of dying out in the near future for lack of participants? Or is it a fishery with a new 'crop' of participants in the wings, perhaps the sons and daughters of present participants, who have an active interest in preserving their lifestyle and carrying on their economic endeavor? Using the management tool of "optimum yield", should we set catch rates at a level such that even though the present participants may not have the capacity to take full advantage of the fish stocks, their sons and daughters will have a more abundant fishery in the future? These are the matters to which adequate demography in the form of age profiles might address itself.

A fourth variable is education. What is the distribution of training and formal education among the participants in the fishery? How can we judge the opportunities which are, or will be available to these people, either in developing their fishery or in the event of a decline in the fishery, if we have no idea of the potentials which the participants themselves possess to take advantage of various alternatives?

Allied in some respects to education is another demographic variable, ethnicity. An ethnic background may serve as a positive factor where it leads to social cohesiveness or economic unity in such cases as the San Diego high-seas tuna fleet. It may also, however, be a negative factor in that ethnicity may embody language barriers which inhibit people of certain ethnic backgrounds from taking advantage of opportunities or conducting business in the larger economic arena.

A final variable, although those which we have listed do not cover the entire range of demographic variables involved in a fishery system, is economics and economic distribution. What is the level of economic resources which are used or generated by the fishery system? More importantly, how are these resources distributed among the participants and constituents of the system? Too often we are satisfied with knowing the total value of the landings in a fishery, and do not press on to discover the distribution of benefits from this value. Does it stay in the fishery 'community'? Does it flow to other locations through absentee ownership channels? Does it go to fishery participants in personal or corporate income, and thus through taxes into the economic base of the public sector of the community?

All of these demographic variables--number, location, age, education, ethnicity, and socio-economics--are directly countable and capable of expression in succinct units of analysis.

Community Organization

Even with the finest demographic description, however, we at best have exactly that; a description. To proceed to analysis, we must make connections between each of the components and sub-sets in the fishery system. These connections, the community organization of the fishery, constitute the second level of analysis.

For example, look at the San Diego high-sea tuna fleet. In that fleet, economics are tied closely to ethnicity. People of

Portuguese, Italian, and Slavic descent pervade the structure and infrastructure of the fleet. Ethnic ties largely determine personal economics; that is, who gets jobs. These same ethnic ties many times determine the control over the management of boats in the fleet, opportunities for ownership through new vessel construction loans, and the economic success of the fishing operation through the socially-determined recruitment patterns which match crewmen to vessels. An awareness of the connection between ethnicity and economics is indispensable to the knowledge of <u>how</u> the economic system works, even though it may not help us to judge how <u>well</u> it works.

Consider the shrimp fishermen in Louisiana. Assume that we know how many of them there are, where they live, and all of the other demographic variables mentioned in the previous section. How can we understand and deal with that system unless we know that the fishery is riddled with different user groups: That there are 'inside' and 'offshore' shrimpers; that there are bayou shrimpers; that there are "East bank" delta shrimpers; and that each of these groups has different preferred fishing grounds, utilizes different species of shrimp at different stages of their growth cycle, and has different economic, social, legal, and political constraints and resources? One could never hope to understand the Louisiana shrimp fishery, or make intelligent regulations or equitably settle fishing disputes arising there, without putting the demographic variables together into a proper fishery 'community' picture.

As a final example, consider the newly-created Fishery Management Councils. Ideally, they all have the same structure, the same categories of participants, essentially the same 'demography'. But does anyone assume that they will all work the same? That they will all produce the same kind of management plans? That they will all respond in the same way to the needs and pressures of fishery problems in their respective jurisdictions? We must recognize that a management regime, be it a Regional Council, an inter-State task force, or a local municipality, is a component in itself and a unique part of the fishery 'community'. This necessitates description and analysis of the connections between the management regime and the other components of the fishery system, exactly as must be done with ethnicity and economy in the tuna fleet or user interests groups in the Louisiana shrimp fishery. Each is a form of giving demographic description a dynamic aspect.

Individuals in the System

Finally, to truly understand our fishery systems we must return to the smallest units of the fishery, to the building blocks, to the people as individuals. This is the third level of analysis. What are their preferences, their goals, their constraints, their values?

In the Pacific Southwest, for example, how could one understand the present conflict in the tuna fishery without understanding people's emotional attachment to certain marine mammals? A tuna fishermen, on the other hand, spends eight months of the year thousands of miles out at sea, effectively isolated from a continuing education about the furor his industry is creating ashore. For many years now, much of this time at sea has been spent experimenting with ways to reduce mammal mortality. Just as the fishermen is isolated from the public, however, the public is unaware of the fishermen's constructive efforts. How can we understand both of their reactions to the problems they encounter without taking account of each's values and experiences?

In New England, the fresh fish industry has gone through a period of adaptation and differentiation. How can we understand this process without considering that certain of those who manage the processing houses have switched to frozen imported fish because of the pressures of the urban business community, while others in smaller communities have continued with the old methods and sources of supply, each reaffirming the values of their personal and social environment?

In the Pacific Northwest, could we understand the problems in the salmon fishery without understanding the preferences of individuals for traditional fishing rights and methods, or a Federal judge's goal of respect for those rights and preferences?

In the South Atlantic, could we understand the concern over the foreign bycatch of billfish without having a feeling for the preferences and values of the deepsea recreational fisherman?

The answer to all of these questions is that we cannot. We cannot hope to describe, or understand, or analyze the workings of our fishery systems without clearly setting out these kinds of preferences, goals, constraints, and values.

The Applications of Social Science Research Results

If we were to obtain information in these three categories on any or all of our fishery systems--the demographic, the 'community', and the individual--the question of the application of those results would remain. What would we do with what we knew?

A primary use for this information is in assessing the impact of plans, developments, and regulations upon fishermen, their families, or the communities in which they live and work. Environmental impact statements, for example, are intended to reflect the effects of an action not only on the physical environment, but also on the human populations who live in the environment.

With the passage of P.L. 94-265, the Fisheries Conservation and Management Act of 1976, another use for this information has been created. This is in the determination of the "optimum Yield" from a fishery or fishery system. Do we want, for example, to manage the growth or recovery rate of a fish stock at below its biologically optimal rate in order to preserve the economic, and thus perhaps the social and cultural life of a fishing community? Do we want to manage the application of fishing effort such that more of a fishery resource will be available for future use, when the human resources and material technology are better developed to use it efficiently and effectively? How are we going to "modify" maximum sustainable biological yield with "economic, social, and ecological factors," as the Act directs, to achieve optimum yield? Without knowledge of the human component of a fishery system, the answer is that we cannot.

The last 'application' of this knowledge, although by 'last' we certainly do not mean to imply that we have exhausted the list, is to us the most important one. It is the underlying principle of all science, the principle of understanding. If we know more about the human components of fishery systems, we understand better how the <u>entire</u> system works.

This is a difficult principle to 'apply'. It involves believing that the world in general works better if people in it understand what goes on, and why. All segments of interaction in fishery systems--between harvesters and managers, owners, and processors, scientists and skippers, resource managers and consumers--all of these interactions will take place more smoothly and with a better chance of satisfactory results if each participant understands the point of view, motives, goals, and constraints of other participants. To sacrifice understanding to expediency or complacency, which we have often unwittingly done by concentrating on the biological component of fishery systems at the expense of the human components, is a short-sighted practice. Performed properly, social science research can help to provide this understanding.

Social Science Disciplines

Space is too short here for a complete discourse on which of the disciplines of social science could best provide which kinds of knowledge and results. Generally, anthropology is best for eliciting an indepth understanding of strictly delimited segments of human systems, and is particularly suited to comparative research. Sociology is more adaptable to survey research, to gathering a wider sample of information in less detail. Political science addresses itself to those behaviors which are directed towards the attainment of "public goals"--competition for power and other resources in a public arena. Psychology focuses on the behavior of the individual as he or she faces the problems of living and interacting with others in the physical and social environment. Economics, the social science discipline which has contributed most to research on fishery systems, studies the flow of goods and services through the fishery system.

The point, however, is that there is a body of scientific research theory and methodology available for the description and analysis of the human component of fishery systems. Some of this research is quantifiable, while some is not. This does not have to affect its value. Words are as good as numbers in communicating ideas, effects, and understanding; oftentimes they are better. A well-described account of the value a fisherman, processor, or consumer extracts from participation in a fishery or the enjoyment of its products is worth at least as much as a tally of the number of such people in the system. We can discuss impacts and optimality, and foster greater understanding with a minimum of quantification.

Conclusion

A primary, if not <u>the</u> primary component of fishery systems is the people who participate in them. There is a body of science whose aim and expertise is in describing and understanding these people. We should use this social science to increase our knowledge of fisheries and fishery systems.

The problems of obtaining and utilizing sociological data are somewhat different from those associated with biological data. With biological research, one is dealing with research subjects whose behavior is generally consistent but very difficult to observe and thus difficult to explain. With social research, there is the great advantage of being able to talk to the research subjects but the great disadvantage of having to deal with values, perceptions, perferences, and a much higher degree of variability in behavior.

In her presentation at the workshop, Susan Peterson outlined some of the problems in utilizing sociological information which has been collected by those whose primary concern was information of other kinds--biological, economic, and so on--and in collecting new sociological information. The problems concern not only correct sampling procedures, but the difficult question of the completeness and reliability of information obtained directly from people who have a particular status and thus particular interests in the fishery.

As Susan points out, however, the description, generalization, analysis, and application of sociological information, while difficult, is possible. Just as the result of biological research is the ability to predict the effects of management alternatives on fish populations, one of the result of sociological research is the ability to predict the effects of those alternatives on human populations.

Social Science Research in the New England Fishing Industry

Susan Peterson
Marine Policy Program
Woods Hole Oceanographic Institution

Presentation made to the Optimum Yield Workshop
Houston, Texas, June 6, 1977

What I have to say follows fairly closely with what Mike Orbach said yesterday afternoon. He pointed out the need for demographic information. What I thought I would do is discuss some of the problems you have in getting that information and what you do with it.

As many of the social scientists in the room know, getting some of the social statistics is very difficult. There isn't very much that is published. What is published is sometimes of questionable value because it's been collected for a very different purpose than what we want to use the data for.

I think all of you know about the existing statistics at the National Marine Fishery Service collected over the past twenty, twenty-five years; information on numbers of vessels, size of vessels, and so forth.

They also collected some information on gear and gear design and frequency of change of that gear. That information is useful to social scientists as well.

Then there has been a lot of information that has been collected by the statisticians, government census people, and so forth, which tends to be useful if you are interested in aggregate forms of data. Unfortunately, most of us are interested in specifics.

There is a fair amount of information collected by anthropologists, sociologists, demographers, and others. Some of that information is useful.

For instance, research has been done in New England looking at specific communities. Researchers have looked at the islands off the coast of Maine, studying the lobster fishery there, which gives us good information about the lobster fishermen, but does not give us a lot of information about the rest of the Maine community.

Some work has been done in Rhode Island by the people at the University of Rhode Island, which has given us some good comparisons about that fishing community as it relates to factory work and other types of employment in that same area. But, again, this data isn't useful if you want to talk about other communities. It is specific to a part of Rhode Island and doesn't allow you to make generalizations about all of New England.

So, one of the problems we have is getting comparable data from one port to the next. Social science has collected information specific to their needs in developing a specific hypothesis, and it is pecular to a specific geographical area.

There are a number of planning documents that have been produced in the last five years that do provide some data. The coastal zone management offices in the various states, and some of the cities have planning offices.

In Gloucester there are good plans. But, again, the data doesn't fulfill the shopping list that Mike more or less developed yesterday, that listed some of the demographic characteristics that we want to know about in the fishing industry.

Now, if you cannot get that information from written sources, from published sources, or from working documents, where do you get it? I think that is the biggest problem the social scientists working with the Councils are faced with right now.

It is not easy to get the data. You have to hire somebody to do the primary research, travelling out in the ports, talking to fishermen, talking to processors, talking to vessel builders, people who work on the boats, and so forth. That is expensive and time consuming. One of the things I am concerned with is how you can get some of the data for less cost.

One of the things that you can do is to find out first of all who you think your population is, and then take a sample of that--go interview a ten percent, twenty percent sample of that population.

But how do you identify the population? Again, you have to go back and depend upon the statistics that have been collected by the National Marine Fishing Service. In this case, one way of obtaining samples is to use the list of vessels that are registered and recorded by the Coast Guard and re-recorded by the Fishery Service.

There is some question about the accuracy of this information. NMFS isn't very quick to report which boats have sunk, or have moved to another fishery. There are many changes that take place that are slow to reach the data sources.

Then, of course, there is the question of the quality of the data. Since the Fishery Service has been the major agency collecting a lot of this, the port agents have been responsible. But, the instructions given to port agents don't always tell them that they should collect such and such data in a certain way. They are simply given a blank piece of paper and are to fill it in.

For instance, on the information on gear, the categories that they fill out are rather broad. For instance, they have otter trawls. And they check whether or not a vessel is using an otter trawl. Not only would we be interested in information about who was using an otter trawl, it would be nice to know what size of net they are using, what style of net they use. It would give you some information on their effort, or capacity. That information just hasn't been available in the past.

So, one of the things we might want to suggest are some small changes that the Fishery Services makes in the way they are already collecting data. The data could be useful if it was just a little more specific than it is now.

A lot of the data, these demographic statistics, or demographic characteristics, come out in terms of numbers. And these numbers can be recorded on a computer. And we can all ask for it and have the computer send it out to you. But, a lot of the information we are interested in isn't numerical. It is qualitative data. It is data that you get by asking fishermen: "Out of the following list of gear types, would you please rank in order the ones you would use first, second, or third," or "Out of all the ports in New England, which ports do you thing are the most successful, or the most profitable, or the best ports to work out of, and why."

A lot of the information we want is qualitative. It is people's opinion about how things work. It's people's reactions to specific questions about how they might do things in the future. And one of the problems is how do we convey this qualitative information in a way that is useful to some of the people on the Council, or to the Scientific and Statistical Committees.

I suggest as social scientists we develop a very rigorous way for communicating this qualitative information. We write it down, but we really don't say in a very rigorous way how the data evolved. People can ask me questions that I can answer. But, why can't I put that all down a rigorous way that somebody else could go and read instead of telephoning and saying, "Susan, how does this really work?"

I can usually respond because I know how it works. But, I have a real problem in providing that information in a rigorous way. I think that is the problem that many of the anthropologists and economists have. There are too many ifs and buts.

Once we have all of these demographic statistics and we put them together and we know how many fishermen there are in New England, what kind of vessels, where they market their fish, what they fish for, what do we do with that descriptive material? Do we turn it into the "Boiler Plate" that goes into Fishery Management Plans? I think that's the suspicion that many people have. And I think that's unfortunate because this "Boiler Plate" is a constantly changing thing.

The haddock stock, for example. The haddock stocks have to be reevaluated every year. In the same way, the human population has to be reevaluated frequently, both to see the new people coming into the fishery and the strategies that are changing. People start marketing in different places, they start substituting one type clam for another type of clam--all sorts of marketing changes take place. And we don't have a very rigorous way of keeping track of these changes.

We need to keep up this information once we have it. We need to have some way of keeping track of who left, perhaps why they left, who came into the fishery, how they got into the fishery, with what type of capital, how did they learn how to handle the different type of fishery, why did they choose a specific port to land their fish--all these questions have to be asked and answered on a rigorous basis.

There also comes a question about why you want to know some fairly esoteric things. Is it simply scientific curiosity, or could some of that information be useful to you.

I can think of a number of things that I have asked people when I am doing their interviews to which they reply, "Why do you want to know what my brother does?"

There are a lot of important questions that I, as a social scientist, see that aren't very clear to many of the biologists. A lot of these questions seem frivolous.

Last month at the Mid-Atlantic Committee meeting I wanted to know not only where fishermen were born, but where they grew up. Everybody said, "Why do you want to know?" If I only get ten questions, that's not in my top ten. But, it gives me some indication of the stability of that population.

For instance, if you look at the information on the Rhode Island Fishery, you find out that out of the 33 fishermen interviewed twenty-nine were born there and twenty-eight were raised there. Now, that's a pretty good indication about the stability of that population group. If I find a lot of people in Gloucester were not born in Gloucester and that Gloucester has accumulated fishermen from all over the country, then it says a whole lot about the flexibility of that fishery, about that port's ability to accommodate people with different backgrounds. There are very real differences from port to port.

I asked a minute ago who do we want to know some of this information. The part that is interesting to me, as a social scientist, is not the demographic information. What I really want to do is make some predictions about what is likely to happen in the population. I want to be able to predict on a long-term basis and on a short-term basis what is going to happen in the fishery.

There are two types of predictions I want to be able to make. One thing I would like to be able to do is predict what the fishermen are going to do to the fish--how they are going to catch it. I want to know if the New England fishermen are gearing up to catch more and more yellowtail flounder, and if the processors are willing to process smaller and smaller flounder. If I know that, I can make some comments about what is likely to happen to the yellowtail population in terms of predators--in this case, both the fishermen and the processor. That's the type of predictions I want to be able to make from the data.

Another type of prediction I want to be able to make is the effect of management plans on populations. The different kinds of information I need to make those two types of predictions are very different. In order to predict what the fisherman and what the processors are doing to do, I can look at the past catch statistics. I can do some interviews of the fishermen and of the processors about what they have done. I can gat a history of them. I can statistically develop a few simple simulations, given their past behavior. I can say their behavior will look something like this, with some sort of fluctuations for increases in horsepower, changes in weather. I can make some predictions about their behavior in relation to stock and fish.

What do I have to know to make a prediction about management plans? There is no way I can look at past behavior and collect some statistics and do the analysis of their past behavior. I can simply use a lot of these demographic statistics, use what the fishermen have told me about their own social structure and different boats. But, they are not predictions based on past behavior. They are predictions based on my feeling, and other social scientists' feelings, about what might happen.

As social scientists, we have not had very much practice in doing that. So, when management plans come out and we want to know what is going to happen to smaller boats, how many boats we're going to put out of business, I would like to know more about how the conclusions were reached. We really don't know what the fishermen are going to do, how they are going to behave under new regulations. They have clever ways of getting around regulations. There are a number of things that will happen that cannot be predicted. It is nice to think we can make some of those predictions on simple economic grounds. But, I don't think we have been very successful. Most fishermen have cleverly managed to get around most of the restrictions in the fisheries.

What I would like to be able to do as a social scientist is to gather information that allows me to make some of these predictions. I would like to give a few examples from the New England Fishery to illustrate some of the problems we have in getting the competent information, getting information of a quality that enables us to do these sort of predictions.

For the last several years, I have been doing research in New England, interviewing fishermen in Portland and Rockland, Maine, New Bedford, and other locations.

We found that some questions that are easy to ask in some ports are terrible to ask in other ports. For instance, in New Bedford, it is easy to go to a fisherman and say, "How much did you gross last year?" He will say $403,000.75.

If I go to a fisherman in Gloucester and say, "What were your gross earnings last year?" He will say, "Why do you want to know?" Then, you will say, "Well, I am doing a study of the income in the fishing industry. I want to know what the various incomes from different types of vessels and ports are" He will say, "Well, what do you do with it?"

Then, I say, "I won't give out any of your financial information. I will accumulate it. It will all be put in with the same size vessel." Then, he will say, "I don't know how much I made last year." Then, you say, "Can you give me a rough estimate?" Then, he says, "Oh, probably not." Then, you say, "Well, if I write down categories of fifty thousand, one hundred thousand to one hundred fifty thousand, can you check off the category you fall in?"

Then, he will say, "how about if you make that zero to one hundred thousand?" "Yes, all right."

Then, you get a category of efficiency of earning from the Port of Gloucester. But, it's like pulling teeth. And you have already spent a half-hour trying to get how much he earned, which is questionable information, because you have such a huge category. If he ticks off the one hundred thousand to the two hundred thousand block, it doesn't give me a whole bunch of information. I probably could have guessed at that. If his boat was in reasonable shape, if he employed two or three people, if he had a wife and children and a reasonable house, he had to earn at least one hundred to two hundred thousand dollars. I didn't need to ask him that.

My purpose is to get qualitative information from which I can make some generalizations from port to port. So, what do I do about that?

There is also the problem of collecting information on ethnic groups. I collect information on ethnic groups in New Bedford because it seems to be an important thing. In New Bedford, the Norwegian fishermen say the Portugese, they don't really know how to fish. When I turn to other ports, you don't have the diversity, you don't have four or five ethnics to be talking about one another. When you go to Gloucester, they are all Italian. They all talk about fishing from an Italian point of view. But, it refers to all of them, not as a group within that port.

So, certain social demographic characteristics, as Mike called them, are important. But, they don't seem to be equally important from port to port. One of the problems we as social scientist have is to decide what to collect and, then, what basis it gives us for generalizations.

I would like to do a summary of what I have said. What I said is basically that there are a number of sources for the information that we as social scientists have. Some of it has been published. Some of it has been collected by the Fishery Service, some by all sorts of census people, some by planners. Some of it has been collected by social scientists themselves and is available to us in the form of data that is both numerical and qualitative. Although we have statistical methods for dealing with both of these, the methods don't always allow us to make comparisions from one port to the next. We get this information so we can write descriptions of ports, so we can make some background assumptions about how the ports work, how income fits, how fishermen fish.

The reason we get it stems from fairly academic interests, things that are interesting to us as social scientists from our own point of view. Some of it we need because it matches the problems of the Councils.

What do we do with it? We use it to try to make some predictions about what is going to happen to the fishing industry, not only in terms of their own behavior, but how they interact with the different species of fish. The latter part is a real problem in that we don't have much skill in doing it. I think that many of the social scientists have to look at how we can make better decisions, how management plans will affect the various aspects of the fisheries.

The "capacity" of a fishing boat or fishing fleet is one of the most deceptive concepts in fisheries management. It is deceptive because the term "capacity" has generally referred to the amount of fish a boat or vessel can carry. The FCMA, however, expands upon this concept of capacity in two ways.

First, any useful definition of the term "capacity" must take into account not only the potential of the harvesters themselves, but also of the processers, distributors and other infra-structural components of the fishery system. If the shore-side sector is small, this broader view may have the effect of restricting the "capacity" of the fishing fleet. I the shore-side operation is large, it may allow the harvestors to argue that their "capacity" is much larger than their historical catches.

Second, the FCMA requires that fishery management plans address not only the <u>physical</u> potential of the system, but also the extent to which that potential will be realized. This involves a much broader range of information, information on factors such as weather, the fishermen's intentions and decision-making processes, and many others.

In their paper on the estimation of capacity, authors Siegel, Mueller, and Rothschild attempt to address this problem of utilization and potential through the use of linear programming and standard regression analysis. As with Jack Devanney's presentation, these procedures are used to attempt to model a system under conditions of uncertainty. In this case, however, the uncertainty concerns the behavior of the fishermen, rather than the fish stocks themselves.

Robert A. Siegel

Staff Economist

Fisheries Management Operations Division

National Marine Fisheries Service

Procedures for the Estimation of Harvesting Capacity
and its Allocation in a Multiple Species Fishery

The FCMA requires that under the National Fishery Management Program any fishery management plan prepared by any Regional Council or the Secretary of Commerce shall:

> "assess and specify...the capacity and the extent to which fishery vessels of the United States, on an annual basis, will harvest the optimum yield..."

This provision of the FCMA requires that fishery management plan assess and specify (1) capacity (potential production capacity), and (2) measure the "extent" of the catch or how much fish the fleet is expected to catch under certain assumptions regarding biological factors and market conditions during a given period of time.

This paper addressed three issues regarding capacity:

(1) definitions and measures of capacity

(2) methods for estimating capacity

(3) estimate capacity and extent to which vessels will harvest certain species.

The method used to estimate capacity and "extent" are summarized as follows:

A. Estimate of Capacity

Economic capacity was defined as: the level of output the fleet would prefer to produce as determined by market conditions, input prices, given technology, and the existing scale of plant.

Capacity was estimated by dividing physical output by an estimate of capacity utilization. For example, if a firm can produce 100 units operating at 80 percent capacity utilization, the capacity is 100/80 or 120 units. The fishery fleet studied was the otter trawl fleet in Maine, Massachusetts, and Rhode Island. Estimates of capacity utilization were not available for this fleet. A proxy measure was developed using an index of catch per gross registered ton using 1957 as a base year.

Potential output was calculated by dividing physical output (landings) by the index of catch per gross registered ton. However, this estimate does not reflect changes in stock abundance or technological conditions. Estimates of potential capacity were deflated by an index of stock abundance for ICNAF designated subarea 5 and statistical area 6 for finfishes and squids. In 1976, the deflated estimate of capacity for the otter trawl fleet was around 300 million pounds on an annual basis. This was adjusted upward by 25 million pounds to reflect technological change.

A linear programming model was then employed to allocate (the estimate of) capacity among various species. The model covered 11 species, 1 vessel category (otter trawls), 1 time period (1 year), and 1 area. The LP model was used to answer the "extent" part of the capacity problem.

The LP model provided estimates of U.S. catches and also surplusses. For the most part, the surpluses were higher than those in the PMP's. However, this model did not include all gear classes nor the mid-Atlantic area. If this was done, the surplusses would probably be lower than the estimate from the base LP model.

The model can be extended to include:

(1) different vessel classes

(2) different gear classes

(3) different fishing areas

(4) more than 1 time period

(5) allowing price to vary as a function of quantity landed.

An example of how to calculate (potential) capacity.

Assume we have an output (landings) series XL, and a catch/gross registered ton series X2 for a particular gear class, e.g., otter trawls.

Period	X1 (landings) (pounds)	X2 (Catch/GRT)	X3 (Index of Utilization)	X4 (potential capacity-pounds)
1	500	40	.53	940
2	800	45	.60	1,333
3	1,500	75	1.00	1,500
4	1,200	60	.80	1,500
5	900	50	.67	1,350

In column 4(X3) we construct an index of catch/GRT using 75--the maximum value--as a base or reference point.

$$\frac{40}{75} = .53 \quad \frac{45}{75} = .60$$

Potential capacity is computed by dividing X1 by X3.

Estimates of potential capacity are shown in X4

This estimate of potential capacity is based on abundance conditions in the base period (#3). To adjust the capacity estimates for changes in stock abundance, we can deflate the estimates by an index of stock abundance.

Assume abundance index is given by X5.

Period	X5 (Abundance index)	X4 (Potential capacity)	X6 (Adjusted estimate)
1	.7	940	658.0
2	.8	1,333	1,066.4
3	1.0	1,500	1,500.0
4	.6	1,500	900
5	.5	1,350	675.0

Potential capacity, adjusted for stock abundance, is calculated by multiplying X5 by X4 to give X6.

Each analysis of a factor or set of factors in fisheries management--biological, economic, sociological, or ecological--is done within a conceptual framework. One such framework for biological factors has been the concept of a maximum substainable yield, a concept whose perdominant analytical form has been that of a stock production model.

Maximum sustainable yield has two connotations. One is that of the largest biological yield which can continuously be produced under specified conditions. Any number of analytical approaches could supply us with an approximation of a figure or range of figures under this general definition.

The other connotation of MSY is that which has evolved in common usage in fishery biology, and which defines MSY as that figure produced by a <u>particular</u> analytical approach; the stock production model. Even though most researchers would admit that no single approach is adequate for every fishery, this particular model is often assumed to be the single approach to which the CMA refers in establishing a central reference point for considerations of optimum yield.

In the following paper, Mike Sissenwine questions not only whether the stock production model is the most useful approach, but also whether it is desirable to attempt a calculation from any particular model for given fisheries on a yearly basis. With new insights into the role of ecological relationships in fishery systems and the time and other constraints imposed by the totality of the management structure itself, his suggestions at the end of the paper concerning these matters deserve careful consideration.

Is MSY an Adequate Foundation for Optimum Yield?

Michael P. Sissenwine

National Marine Fisheries Service
Northeast Fisheries Center
Woods Hole Laboratory
Woods Hole, Massachusetts 02543

Abstract

Traditionally, maximum sustainable yield (MSY) has been estimated from stock-production models. A second approach has been to calculate MSY as the product of average recruitment and maximum yield per recruit. These approaches to MSY are an inadequate foundation for optimum yield. The most common method of fitting the stock-production model to data may falsely indicate that the model satisfactorily describes a fishery because of the manner in which fishing effort is calculated. Due to random fluctuations in productivity of fisheries, the fishing mortality rate corresponding to MSY may not be sustainable. Maximizing yield per recruit may lead to a severe depletion of spawning stock size and recruitment failure. For multispecies fisheries, independent management of several species aimed at achieving MSY may be self-defeating.

The concept of MSY implies constancy in yield. A constant yield can be achieved by setting annual catch at a low enough level to assure conservation of the fisheries resource even during a series of years of low productivity, but during years of higher productivity yield may be lower than is necessary to achieve conservation objectives. Greater utilization of a fishery resource may be effected by adjusting yield in response to fluctuations in productivity and the current status of the resource.

July 11, 1977

Introduction

The optimum yield (OY) of a fishery is the amount of fish: (1) which will provide the greatest overall benefit to the nation, with particular reference to food production and recreational opportunities; and (b) which is prescribed as such on the basis of the maximum sustainable yield (MSY) from such fishery, as modified by any relevant economic, social, or ecological factors (Public Law 94-265, 94th Congress, H.R. 200, April 13, 1976). In theory, then, the first step in determining the optimum yield of a fishery is to estimate MSY. If stock size is below the level corresponding to MSY (P_{msy}), optimum yield during the recovery period of the stock might be set below MSY, while if stock size is above P_{msy}, optimum yield might briefly exceed MSY in order to use the apparent excess stock. Such modifications of OY from MSY would qualify as ecological factors. Although the concept of optimum yield is sufficiently flexible to allow large departures from MSY, MSY is undeniably the foundation of optimum yield (according to the law) and where relevant economic, social, and ecological factors are not apparent, MSY and OY are equivalent. But, in practice, is there sufficient information to estimate MSY for most of the species for which management plans are needed? Does the traditional MSY strategy of exploitation really result in a sustainable yield? Does the present state of the art of fish population dynamics suggest a more workable management strategy? The remainder of this paper will address some aspects of these questions.

Estimating MSY

MSY is often estimated by application of a stock-production (surplus) model such as the model described by Schaefer (1954). The Schaefer model postulates that conditional production of a stock when unexploited is a function of stock size (Figure 1). Surplus production means an increase in biomass in excess of losses to natural mortality. In theory, the unexploited stock size (virgin stock size) is P_{max} at which point there is no surplus production. Under exploitation, the stock adjust to a new equilibrium level at which point yield equals surplus production. Clearly, the population is unable to cope with sustained yields in excess of MSY. If the yield continues to exceed surplus production, the stock will eventually decline to economic extinction (abundance level at which it is no longer profitable to fish).

The shortcomings of stock-production models are well known (for example, they ignore age-class structure, delays between changes in production and changes in stock size, and environmentally induced fluctuations) but these models are still widely applied. Application of a stock-production model requires catch and standard effort data over a substantial number of years. The time series of data must be long enough to include periods of favorable and unfavorable environmental conditions and a wide range of population sizes. In fact, stock-production models are poor at locating MSY unless stock size has been reduced below P_{msy} for some of the year considered.[1] This is a significant shortcoming when applying the method to a developing fishery. Nevertheless, the approach is appealing because detailed biological information about the exploited species is not required.

For a population at equilibrium, catch per unit effort (CPUE) is inversely correlated with effort and the slope and intercept of the line relating these two variables determine the parameters of the Schaefer stock-productions model (and MSY). Clearly, populations are seldom at equilibrium, therefore Gulland (1961) suggested using running averages of effort to correct for nonequilibrium.

---

[1]Gulland, J. A. 1975. Some thoughts on management strategies. (Unpubl.), 3 p.

Fox (1975) shows that in some situations weight averages of effort more closely approximate the equilibrium level of effort corresponding to a particular annual catch than running averages. I am not aware of any rigorous general examinations of the adequacy of the running average correction method, but, assuming it is acceptable, an estimate of annual effort is needed. For many fisheries, CPUE is more easily estimated from interviews of fishermen than is total effort. Therefore, effort is estimated by dividing catch by CPUE and then the stock-production model is fit by regressing CPUE vs running average of catch/CPUE as in Figure 2. While for this set of data there is scatter about the line, the fit is significant at the 5% level and MSY is estimated as the intercept squared divided by minus four times the slope or 108.5. In fact, the catch and CPUE data on which Figure 2 is based were drawn from a table of random numbers and are clearly unrelated. The apparent fit of the model results because of the manner in which effort data are calculated from catch and CPUE. The entire credit for this disheartening example of a serious potential source of error in the estimation of MSY belongs to Knights and Pope[2] of Lowestoft, England. They reported this work to ICNAF (in a working paper) in 1975, but since this work is not widely available, I decided to present it at this conference.

Is MSY really sustainable?

Let us assume that the Schaefer (1954) stock-production model does describe the population dynamics of an exploited species under average environmental conditions and that the parameters provide an exact fit. Of course there are environmentally induced random fluctuations in production of the population,

[2]Knights, B. J. and J. G. Pope. 1975. A note on the construction of scientific fig leaves. (Unpubl.), 5 p.

but it is often assumed that if the fishing mortality that corresponds to MSY is maintained, the long-term average catch should be MSY and the population should fluctuate about P_{msy}. Unfortunately, two recent papers (Doubleday 1976 and Sissenwine 1977) do not support this assumption.

Several examples of the Schaefer model, with random fluctuations in production, were simulated numerous times with exploitation at various levels using the Monte Carlo method. Random fluctuations were lognormally distributed and sometimes autocorrelated. Only realistic values of variance (σ^2) and autocorrelation coefficients (ρ) were considered. Some of the results are shown in Figures 3-6. These results are for a stock-production model where F_{msy} = 0.5 which is probably realistic for many species of the Northwest Atlantic. Population size at the beginning of each simulation was P_{msy} and each curve represents 100 simulations for 25 years each. Catch relative to MSY is reported on the horizontal axis and percent of the years simulated is reported on the vertical axis. Population size during each year is proportional to relative catch since fishing mortality is constant.

For F = 0.6 ($>F_{msy}$) average relative catch is near 1.0 (ranging from 0.5 to 1.5) for the very low value of σ^2, but when random fluctuations are autocorrelated and variances are realistically larger, relative catch is usually substantially below 1.0 (MSY). Clearly F should not exceed F_{msy}. What about when $F = F_{msy}$? The results are not strikingly different from the simulations of overfishing. For realistic values of σ^2 and ρ, relative catch is usually below 1.0 and often below 0.5. If the simulations are viewed over time (instead of all years lumped together), it becomes apparent that as σ^2 and ρ increase there is a greater probability of a stock fished at F_{msy} declining sharply. A 20% probability of catches less than 25% of MSY is indicated for some of these simulations. When F is below F_{msy} (0.4 and 0.3), some small reduction in average catch results but a substantial reduction in variability of catch is perhaps more noteworthy.

In an independent study similar to the one I have just described, Doubleday (1976) reaches the same conclusions. He considers a constant catch (at MSY) strategy as well as the constant fishing mortality approach. Normally distributed random fluctuations were also considered. Doubleday concluded that a catch and fishing mortality rate of about two-thirds the MSY level is more likely to be sustainable than the MSY level.

Variability in Recruitment

Much of the variability in production of fish populations results from fluctuations in recruitment. If a suitable data base were available (preferably catch at age over a decade or more) average annual recruitment could be calculated. The maximum average yield (MAY, on an annual basis) could be calculated by multiplying the maximum yield per recruit (YPR) when fishing at F_{max} (Beverton and Holt 1957; Figure 7) by average recruitment. What I have described as MAY is sometimes equated with MSY. There are several dangers in setting expectations of yield at MAY and maintaining a constant fishing mortality of F_{max}. First, the curves relating YPR to fishing mortality are often rather flat-topped so that F_{max} is a rather high value resulting in very substantial reductions in spawning stock size and a small yield per marginal unit of fishing effort. Clearly, the reduction in spawning stock size resulting from fishing at F_{max} threatens the continuation of average recruitment at the level used to calculate MAY. Second, for more peaked YPR curves where F_{max} is more clearly defined, F_{max} is sensitive to estimates of natural mortality[3] and unfortunately natural mortality is probably only well known for a few species. The application of F_{max} to fisheries management in the International Commission for the Northwest Atlantic Fisheries (ICNAF) until recently was probably partially responsible for the decline of some species (cod stocks off Greenland and Labrador, for example). Thus optimum yield based on MSY when taken to be equivalent to MAY probably will not result in a sustainable yield.

The consideration of some value of F less than F_{max} is desirable. $F_{0.1}$ has been used recently in ICNAF because fishing at this level results in a smaller reduction in spawning stock while yield per recruit at $F_{0.1}$ is usually only slightly lower than at F_{max}. $F_{0.1}$ is defined as the point on the YPR curve where the slope equals 1/10 the slope of the curve through the origin (Figure 7). Gulland and Boerma (1973) described the economic attributes of $F_{0.1}$. While $F_{0.1}$ is clearly preferable to F_{max} (from a conservation standpoint; ICNAF 1976), it is usually impossible to judge what impact fishing at $F_{0.1}$ will have on recruitment since stock-recruitment relationships have seldom been established. In fact, recruitment has been more closely correlated with environmental variables (Sissenwine 1974; Flowers and Saila 1972; for example) in many cases than with size of spawning stock. This does not imply that stock-recruitment relationships do not exist, but that, in a complex ecosystem, fluctuations in recruitment due to other causes mask such relationships. This being the case, is the concept of MSY, which unrealistically implies the possibility of achieving constancy, of any value? Recognizing this, most assessment scientists interpret MSY as maximum average long-term yield.

[3]Gulland, J. A. 1975. Op. cit.

Two recent papers (Nelson, Ingham, and Schaaf 1977; Sissenwine 1977) have considered both the effect of spawning stock size and environmental fluctuation on recruitment. Nelson et al. related deviations in recruitment from a Ricker (1958) stock (actually egg production) -recruitment curve of Atlantic menhaden to anomalies in zonal Ekman transport. Zonal Ekman transport is the mechanism that transports larvae from offshore spawning grounds to inshore nursery areas. The paper shows that greater stability in catch and stock size could have been achieved by adjusting the intensity of exploitation on a yearly basis to predicted environmentally induced fluctuations in recruitment. The catch for 1961-1972 would have averaged slightly higher than was actually achieved (419,000 MT vs 410,000 MT) but still vastly lower than the MSY level estimated from a stock-production model (600,000 MT).

Sissenwine (1977) developed a model of the southern New England yellowtail flounder fishery that simulates recruitment as a linear function of egg production with adjustments for anomalies in temperature. Growth was also temperature dependent. This model was successful in explaining 85% of the variation in catch observed between 1943-1965 and successfully predicted catch in more recent years although data from these years was not used in the development of the model (Figure 8). The model shows that if fishing mortality were adjusted in response to predicted fluctuations in production, population size could have been better stabilized and yield increased.

These two examples of environmentally responsive fisheries point out that the concept of MSY lends little to rational management although some consideration of the yield achieved by applying a target fishing mortality rate (such as $F_{0.1}$) to the median level of recruitment may be of value to government and industry planners.

Ecosystem Management

The concept of MSY developed during a period when single-species management was appropriate. Exploitation was limited to a few species in any particular ecosystem and important interacting (prey, predators, or competitors) species were usually unaffected. This is no longer the case in many areas, the Northwest Atlantic shelf of the USA being a prime example. Here otter trawls exploit almost all species, resulting in a decline in relative abundance of the total finfish and squid biomass in research vessel bottom trawl surveys (Figure 9, Clark and Brown 1977). Clearly, the productivity of some species must be related to the state of other components of the ecosystem.

Two large components of the exploited biomass of the New England and Mid-Atlantic continental shelf are Atlantic mackerel and sea herring. The MSY of herring and mackerel has been estimated at about 180,000 MT (for ICNAF SA 5+6) and 313 MT (for ICNAF SA 3-6), respectively.[4] Catches in excess of these MSY levels have occurred but periods of high catch for each species have not coincided. Studies of the food habits of these species indicate that it may not be possible to maximize production of both species at once because of constraints imposed by the nature of the ecosystem. These studies (Maurer 1976) have shown that mackerel and herring may be competitors. Table 1 from these studies indicates that 16 of 29 generic food items of mackerel and herring taken in research vessel surveys were co-occurring. Figure 10 shows the degree of overlap for certain key prey of mackerel and herring taken at the same station.

---

[4] Anderson, E. D. 1976. Estimates of the MSY of fish stocks in ICNAF SA 5+6, NEFC Lab. Ref. No. 76-05. (Unpubl), 2 p.

Our understanding of trophic dynamics is still in its infancy. The information I have presented is inadequate to conclude that mackerel and herring are competitors since a food limitation has not been shown. This discussion does demonstrate that efforts to manage numerous species separately may be frustrated by nature's own strategy. Optimum yield must be constrained by the options and choices that the ecosystem allows.[5] While optimization based on dynamic ecosystem models is beyond the state of the art, common sense should lead us to dismiss a concept of optimum yield drawn from a series of single species MSY's. ICNAF in 1974 took a first step toward ecosystem management by establishing a single catch quota on all finfish (excluding sharks, billfishes, tuna, swordfish, and menhaden) and squid. Brown et al. (1976) estimated the MSY of this aggregate biomass as 900,000 MT, considerably less than the 1,300,000 MT total of MSY's for individual species. Of course this total exploitable biomass estimate of MSY has many of the same weaknesses that were pointed out for single species MSY estimates earlier. Furthermore, total biomass management of this form cannot be readily applied to determine optimum yield of individual species which is clearly necessary to avoid overfishing (economic and biological) of desirable species.

Other Alternatives for Optimum Yield

I would like to briefly describe two workable alternative approaches to optimum yield. The first alternative would be to set yield at a constant rate (catch per year, for example) low enough to assure that stock size would remain at some minimum acceptable level even if recruitment were poor for a series of

[5] Hennemuth, R. C. 1977. Some biological aspects of optimum yield. (Unpubl.), 11 p.

years. It can be argued that this catch rate corresponds to a strict interpretation of MSY. The acceptable population level might be set at a spawning stock size where good recruitment has often occurred, a level deemed necessary to support some desirable predators, or at a level that assures a high catch per effort (thus making fishing profitable). The accepted level could be any level indicated by ecological, economic, and social factors which does not violate the national standards set forth in the Fishery Conservation and Management Act of 1976. Unfortunately, during years of high recruitment, yield may be far lower than is necessary to achieve management objectives, but this form of regulation may be necessary where the impact of different catch rates cannot be predicted on a year to year basis. Management of short-lived species, such as the short-finned squid, may have to be of this type. For this type species, fluctuations in recruitment are at present unpredictable and virtually none of the individuals in the population when data were gathered to set the yield for this year are still alive.

The second alternative is to vary the catch rate over time (from year to year for example) in response to recruitment and the current status of the stock relative to some benchmarks. Appropriate benchmarks would be a minimum acceptable stock size (P_m) and a target stock size (P_{opt}). The determination of these levels should incorporate as much information about trophic dynamics as is available, but at present they will probably be based on observations of the productivity of the fishery at various past stock sizes. Optimum yield should be based on the expected status of the fishery at the beginning of the period to be regulated (P_o). This status could be predicted based on commercial catch and effort data and research survey data. Recruitment may be predicted from pre-recruit indices or from established forecasting models based on environmental variables. Obviously it is advantageous to set yield as near the beginning of the period being regulated as possible (from a scientific point of view). The appropriate level of yield would be based on P_o relative to P_m and P_{opt}. For example, if $P_m \leq P_o < P_{opt}$, yield might be set at some minimum acceptable level (based on economic or social factors) as long as this would not depress the stock below P_m by the end of the year. Above P_{opt}, the highest catch that would maintain the population at P_{opt} (surplus yield) could be allowed, while zero directed catch would be necessary if P_o is below P_m. In some cases it may be more appropriate to set optimum yield by applying a particular desired level of fishing mortality when $P_o \geq P_m$.

Optimum yields as described in preliminary management plans and management plans for the New England and Mid-Atlantic continental shelf were based on modifications of the alternatives described above. While past estimates of MSY have served as bases for target stock sizes, they are not necessary to determine optimum yield.

References

Beverton, R. J. H., and S. J. Holt. 1957. On the dynamics of exploited fish populations. Fish. Invest. Minist. Agric., Fish. Food (G.B.), Ser. II, 19, 533 p.

Brown, B. E., J. A. Brennan, M. D. Grosslein, E. G. Heyerdahl, and R. C. Hennemuth. 1976. The effect of fishing on the marine finfish biomass in the Northwest Atlantic from the Gulf of Maine to Cape Hatteras. Int. Comm. Northw. Atlant. Fish. Res. Bull. No. 12, 49-68.

Clark, S. H. and B. E. Brown. 1977. Changes in biomass of finfish and squid from the Gulf of Maine to Cape Hatteras, 1963-1974, as determined from research vessel survey data. Fish. Bull., U.S. 75(1):1-21.

Doubleday, W. C. 1976. Environmental fluctuations and fisheries management. Int. Comm. Northw. Atlant. Fish., Selected Papers (1):141-150.

Flowers, J. M. and S. B. Saila. 1972. An analysis of temperature effects on the inshore lobster fishery. J. Fish. Res. Bd. Can. 29:1221-1225.

Fox, W. W. 1975. Fitting the generalized stock production model by least squares and equilibrium approximation. Fish. Bull., U.S. 73(1):23-37.

Gulland, J. A. 1961. Fishing and the stocks of fish at Iceland. Fish. Invest. Minist. Agric., Fish. Food (G.B.), Ser. 2, 23(4), 52 p.

Gulland, J. A. and L. K. Boerma. 1973. Scientific advice on catch levels. Fish. Bull., U.S. 71(2):325-335.

ICNAF. 1976. Standing Committee on Research and Statistics. Proc. of Special Meeting, September 1975. Int. Comm. Northw. Atlant. Fish., Redbook, pp. 5-8.

Maurer, R. 1976. A preliminary analysis of interspecific trophic relationships between the sea herring, Clupea harengus Linnaeus, and the Atlantic mackerel, Scomber scombrus Linnaeus. ICNAF Res. Doc. 76/VI/121. (Mimeographed), 22 p.

Nelson, W. R., M. C. Ingham, and W. E. Schaaf. 1977. Larval transport and year-class strength of Atlantic menhaden, Brevoortia tyrannus. Fish. Bull., U.S. 75(1):23-41.

Schaefer, M. B. 1954. Some aspects of dynamics of populations important to the management of commercial marine fisheries. Bull. Inter-Amer. Trop. Tuna Comm., No. 1(2):27-56.

Sissenwine, M. P. 1974. Variability in recruitment and equilibrium catch of the southern New England yellowtail flounder fishery. J. Cons. Int. Explor. Mer 36:15-26.

Sissenwine, M. P. 1977. A compartmentalized simulation model of the southern New England yellowtail flounder (Limanda ferruginea) fishery. Fish. Bull., U.S. 75(3):465-482.

Sissenwine, M. P. 1977. The effects of random fluctuations on a hypothetical fishery. Int. Comm. Northw. Atlant. Fish., Selected Papers 2:137-144.

Table 1. Co-occurring generic food items (from Maurer 1976).

Genera	Herring	Mackerel
Gammarus	+	+
Hyperia	+	+
Diastylus	+	-
Crangon	-	+
Pagurus	-	+
Pandalus	-	+
Meganyctiphanes	+	+
Thysanoessa	-	+
Neomysis	+	+
Calanus	+	+
Centropages	+	+
Temora	+	+
Rhincalanus	+	+
Pseudocalanus	+	+
Euchirella	+	-
Metridia	+	+
Pleuromamma	+	+
Candacia	+	+
Tortanus	+	-
Oithona	+	+
Macrosetella	+	-
Clione	-	+
Limacina	+	+
Sagitta	+	+
Ophiura	-	+
Oikopleura	+	+
Fritillaria	-	-
Merluccius	-	+
Ammodytes	+	+

16/29 co-occurring genera

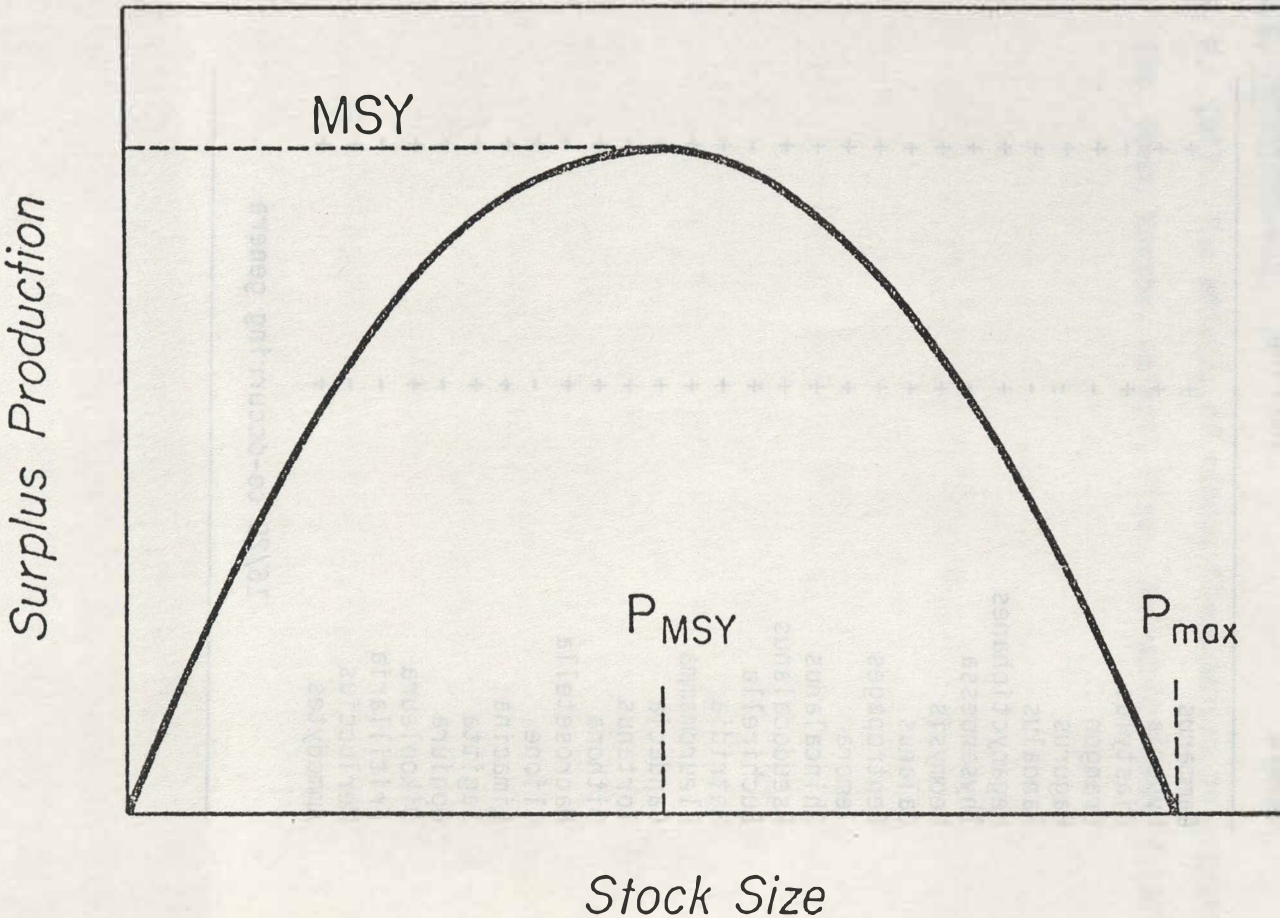


Figure 1. Stock-production (surplus) function.

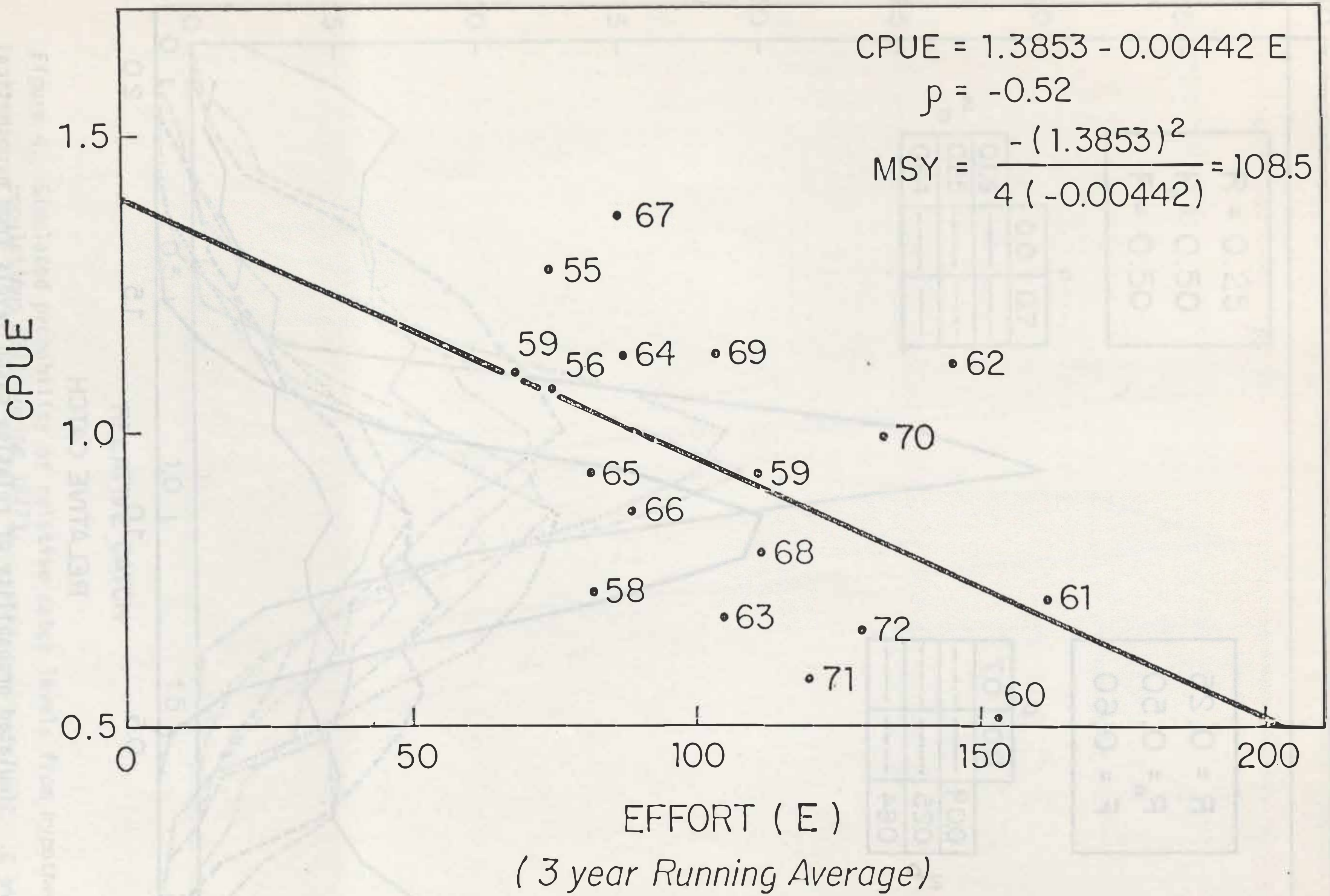


Figure 2. Estimating the MSY of a hypothetical fishery by simple linear regression (after Knights and Pope. Unpubl.).

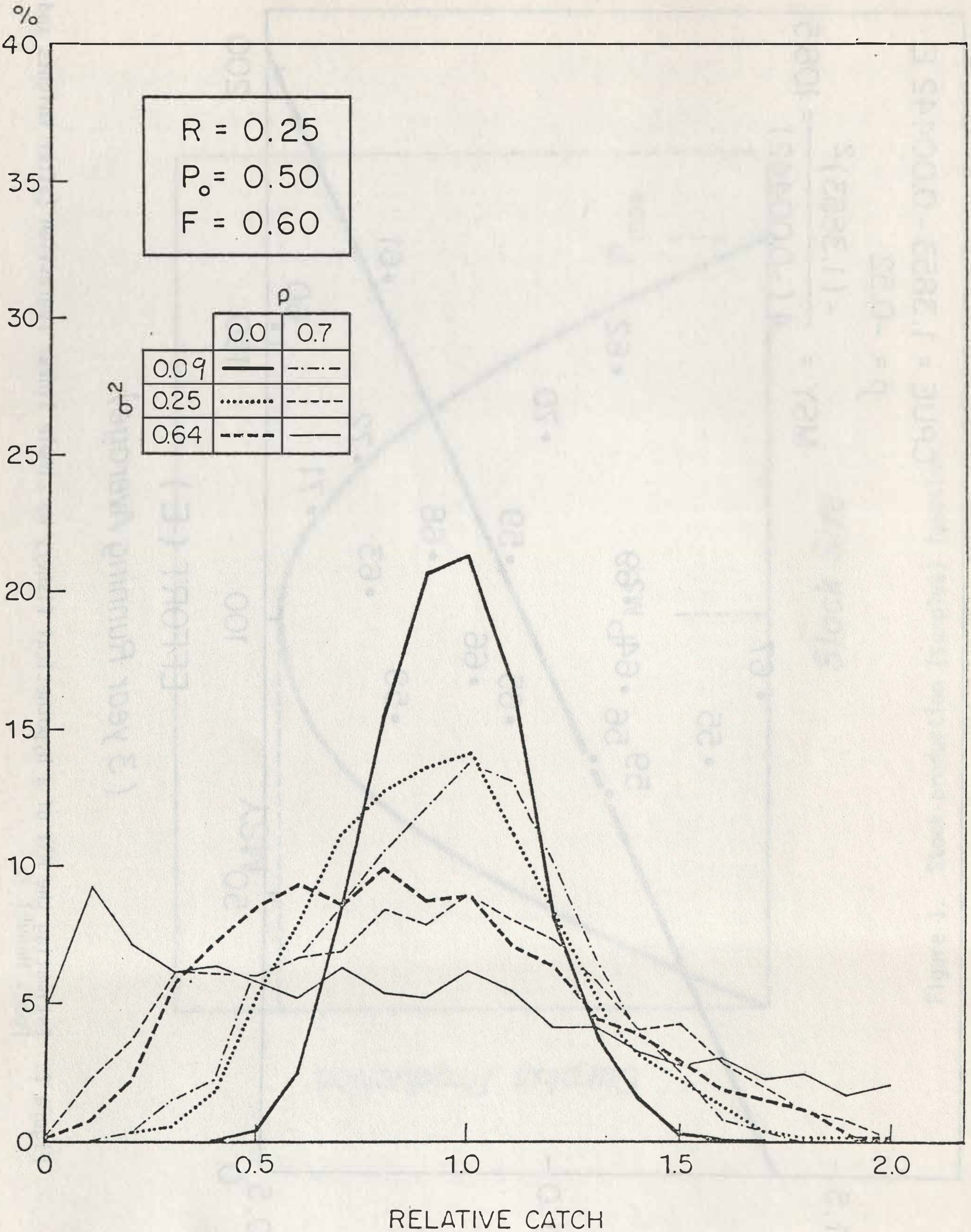


Figure 3. Simulated probability of relative catch levels from hypothetical populations (Sissenwine 1977).

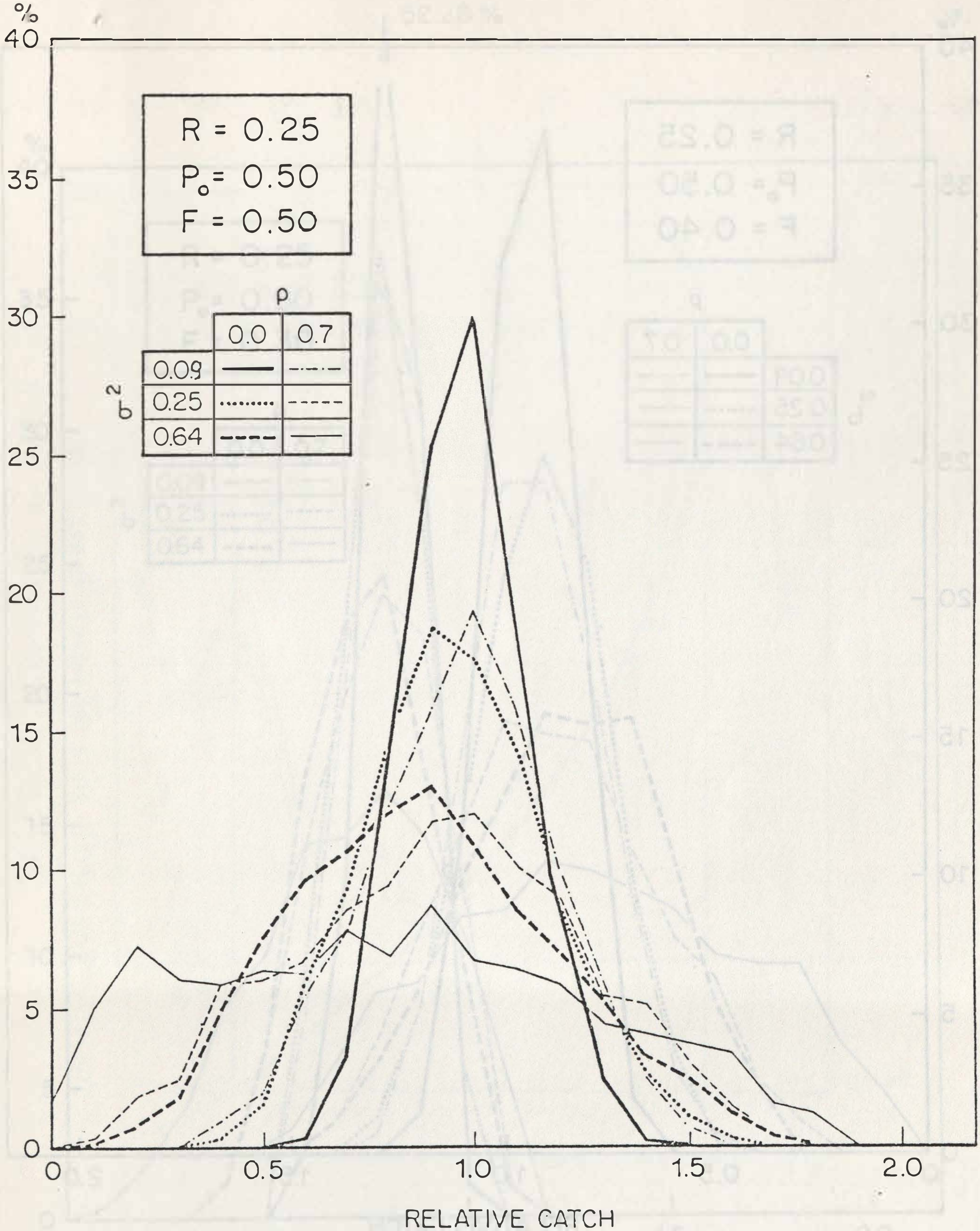


Figure 4. Simulated probability of relative catch levels from hypothetical populations (Sissenwine 1977).

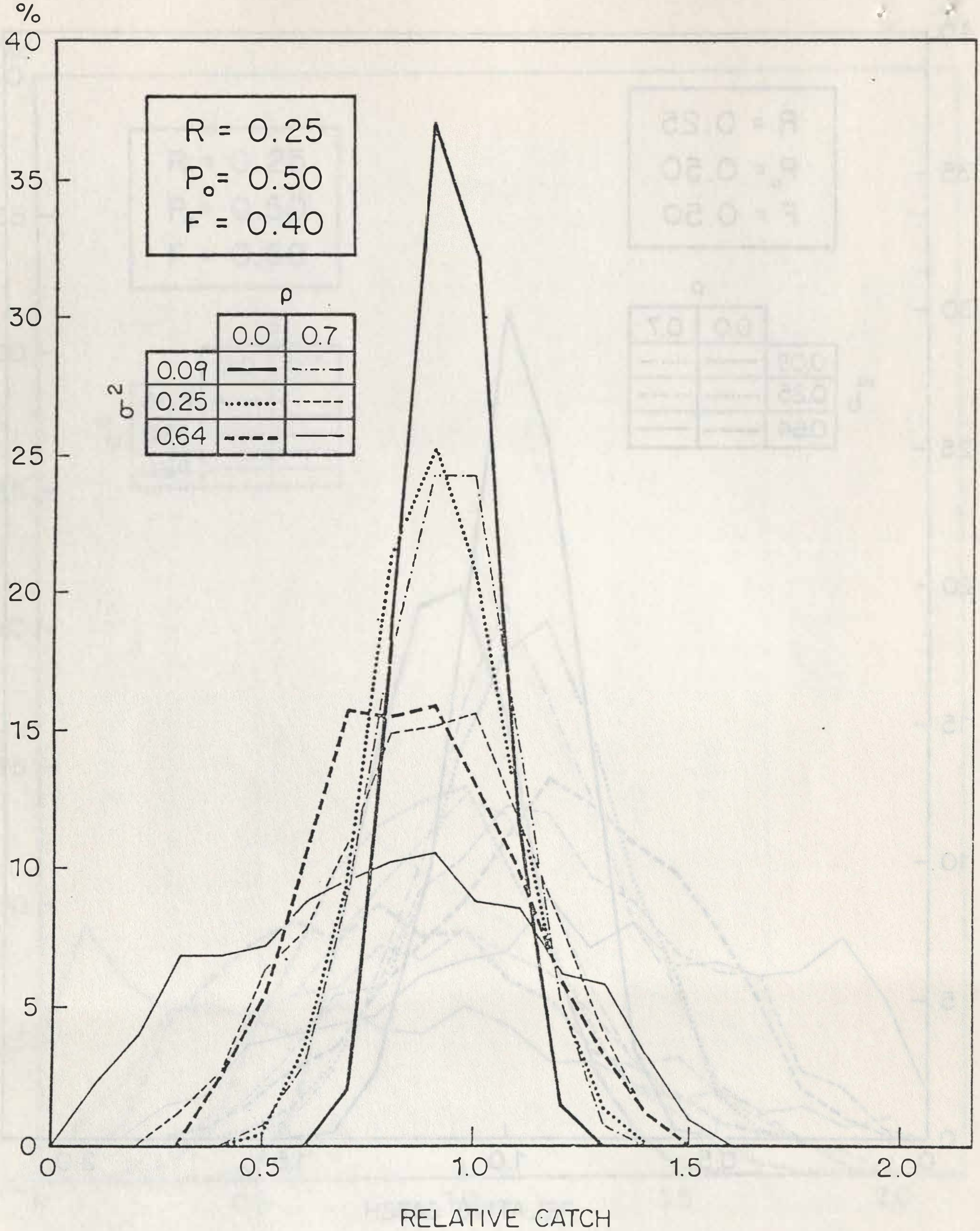


Figure 5. Simulated probability of relative catch levels from hypothetical populations (Sissenwine 1977).

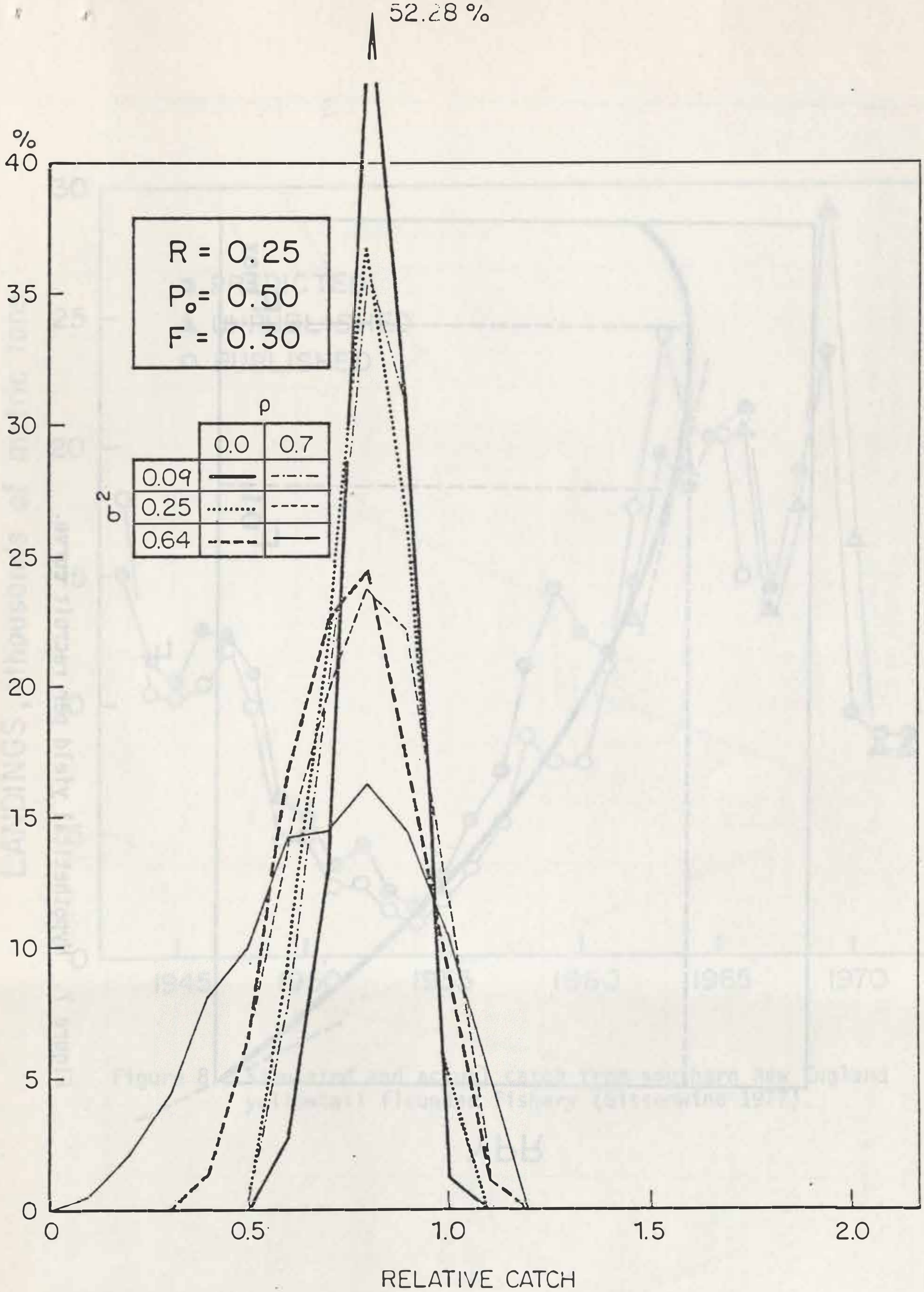


Figure 6. Simulated probability of relative catch levels from hypothetical populations (Sissenwine 1977).

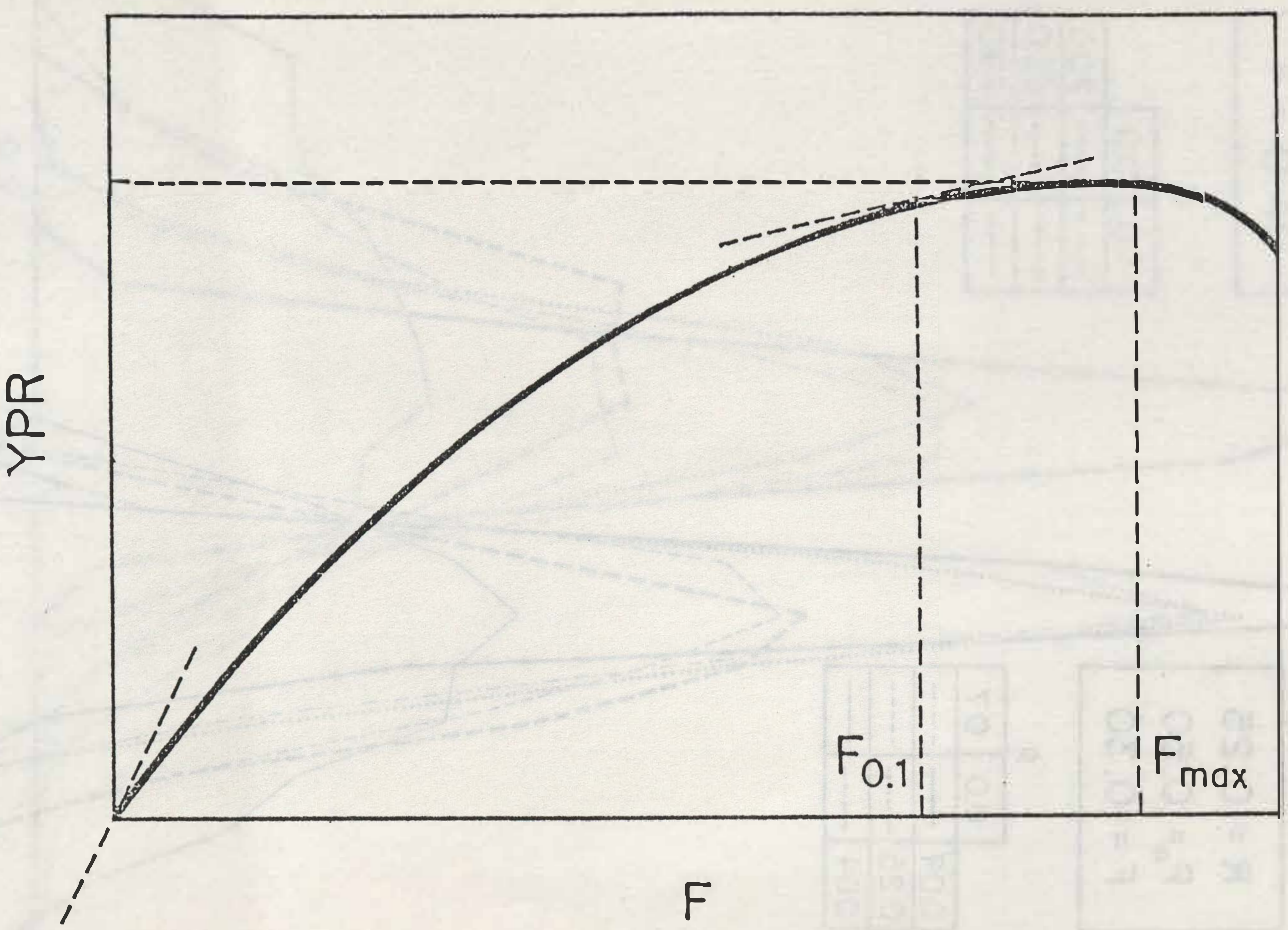


Figure 7. Hypothetical yield per recruit curve.

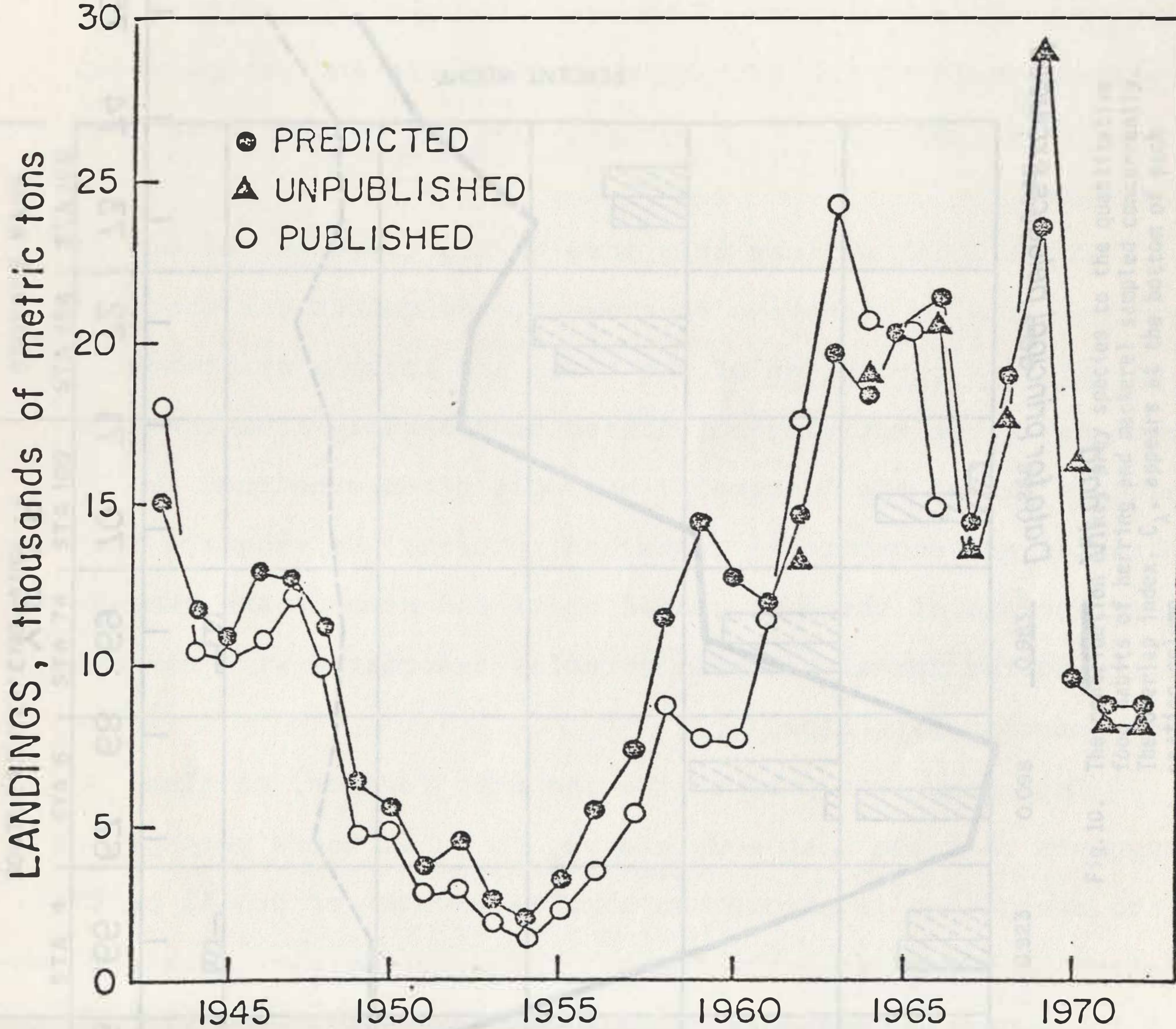


Figure 8. Simulated and actual catch from southern New England yellowtail flounder fishery (Sissenwine 1977).

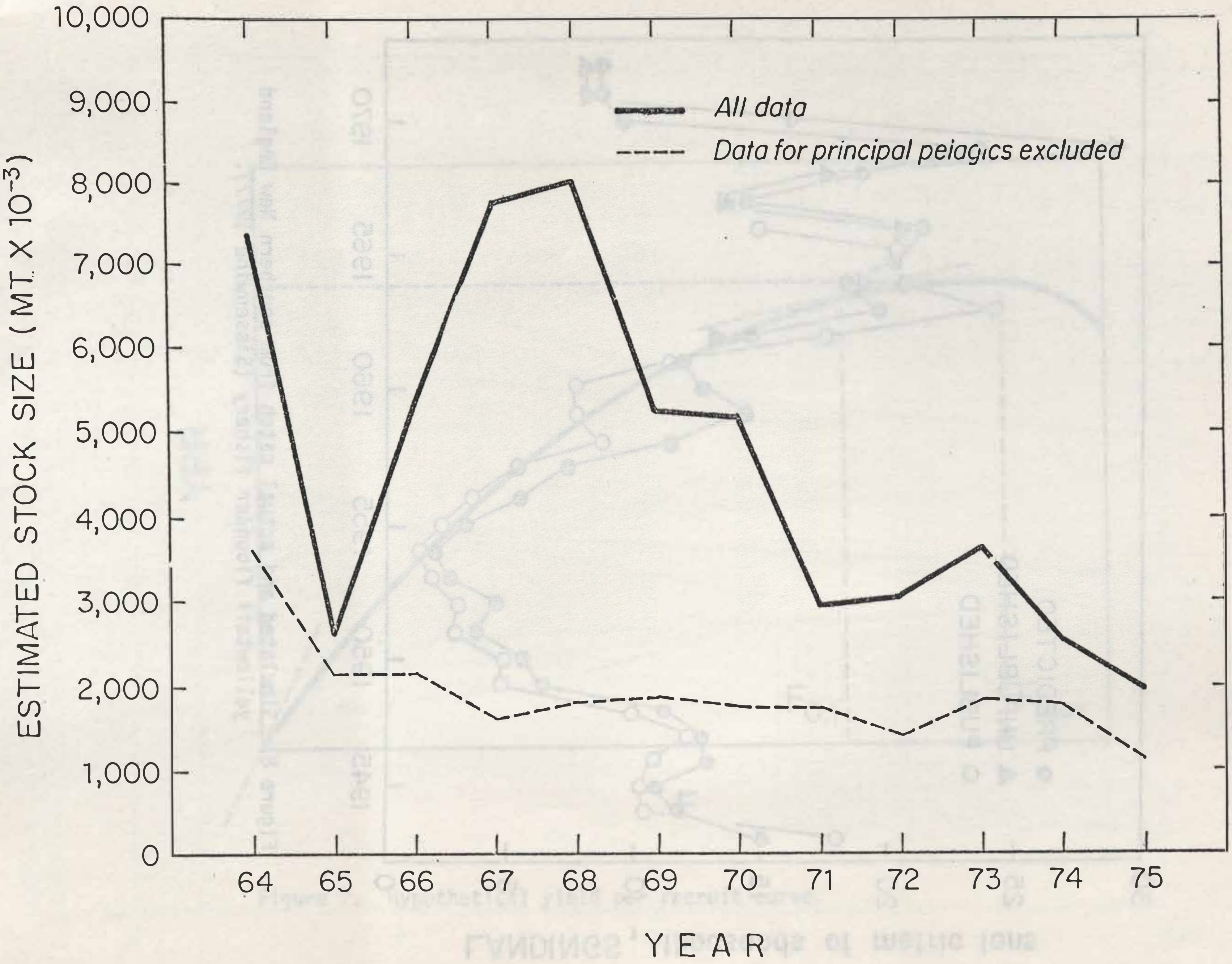


Figure 9. Estimated total finfish and squid biomass of Atlantic continental shelf of USA north of Cape Hatteras (Clark and Brown 1977).

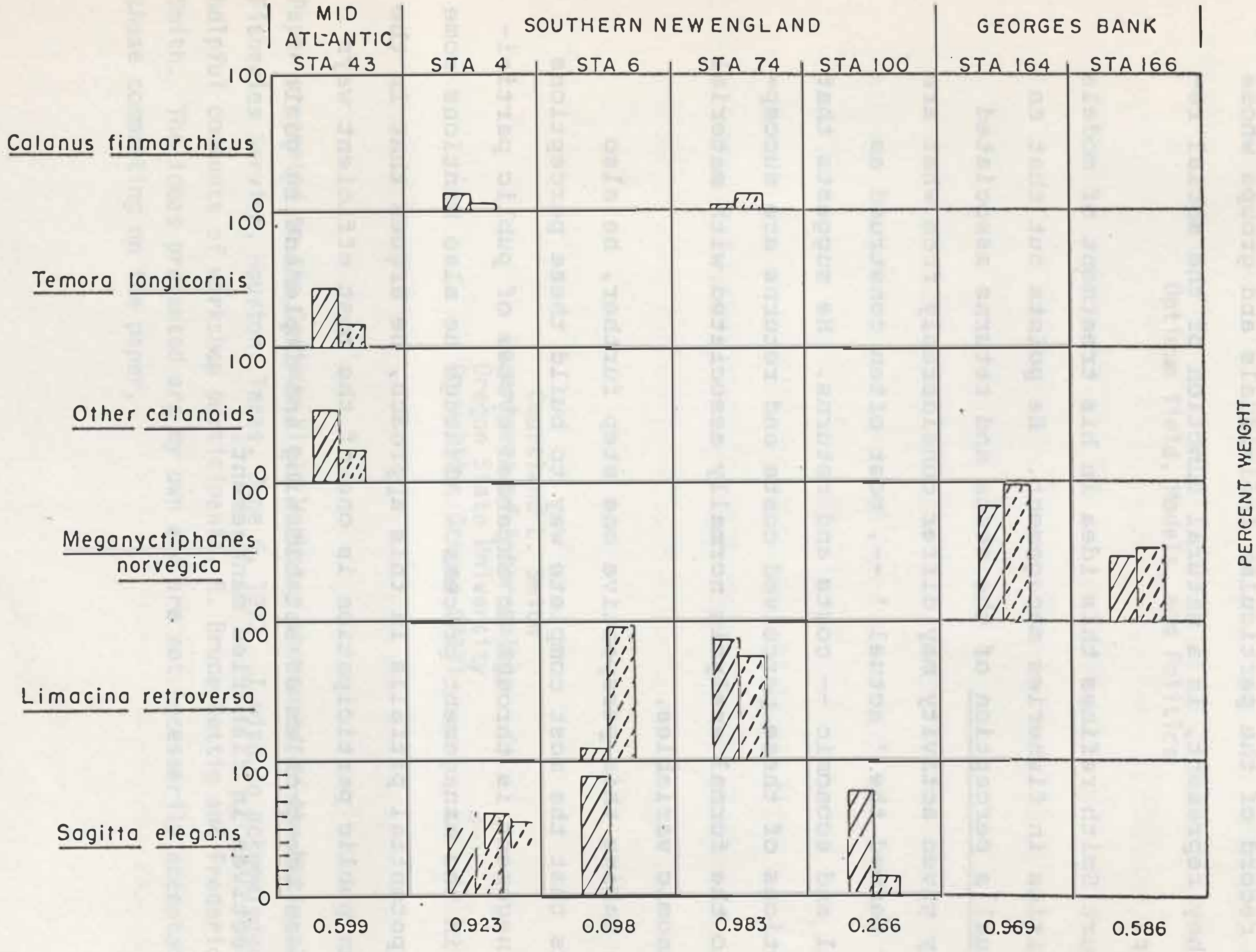


Fig. 10. The contribution of key prey species to the quantitative food habits of herring and mackerel sampled concurrently. The overlap index, C_λ, appears at the bottom of each station column.

A central focus of fishery management plans is the set of objectives which each one is intended to fulfill. Formulating a clear statement of these objectives, including a concise record of the particular individuals and groups whose views they represent, is a natural function of the social researcher.

Court Smith refines this idea in his treatment of models and politics in fisheries management. He points out that an <u>individual's perception</u> of the costs and returns associated with any given activity may differ considerably from what are usually termed the ' actual ' --, most often construed as material and economic -- costs and returns. He suggests that descriptions of these perceived costs and returns are succeptable to the formal analysis normally associated with material and economic variables.

In taking this perspective one step further, he also suggests that the most complete way to build these perceptions into management is through an expanded system of public participation in the management process. Although he also mentions some of the potential pitfalls in this approach, he argues that in the long run public participation is one of the most efficient ways to address the problem of establishing and implementing goals and objectives in fisheries management.

Optimum Yield, Models, and Politics

Courtland L. Smith
Department of Anthropology
Oregon State University
Corvallis, Oregon 97331

Paper presented to the Optimum Yield Workshop sponsored by the National Marine Fisheries Service, Houston, Texas, June 6, 1977. I wish to acknowledge the helpful comments of workshop participants, R. Bruce Rettig and Frederick J. Smith. The ideas presented are my own and are not necessarily accepted by those commenting on the paper.

What is optimum is a value laden decision. Optimality depends on objectives to be achieved and relative weights assigned each objective. Modeling optimum yield, then, is not solely a scientific and technical decision, although scientific and technical expertise can make an important contribution. Deciding on objectives is a political decision which must be worked out in a political context.

Two related political problems face optimum yield modeling. First, no model can be both logically consistent and complete. Because of this, any model is politically vulnerable to being criticized for inconsistency or incompleteness. Second, no model is value free. Management models are based on assumptions about how social systems should operate. Thus, objectives built into a model should be made explicit and related to public desires. Objectives for fisheries management are best identified and weighted in a process of public participation. Regional fishery management councils should consider allocating funds to improve this process.

Logical Consistency and Completeness

A model is a system of axioms which can be expressed mathematically. Models, however, contain the inherent flaw that a "logical system which has any richness can never be complete, yet cannot be guaranteed to be consistent" (Bronowski 1966:3). This summarizes the modeling implications of the Entscheidungsproblem (decision problem), posed by Hilbert and Ackermann (1928). They asked whether all mathematical assertions which make sense could be proved true or false. Theorems by Gödel (1930), Turning (1936), Church (1936), and Tarski (1956) all point to the unsolvability of this question. Bronowski (1966:4) summarizes the dilemma

> . . .every axiomatic system of any mathematical richness is subject to severe limitations, . . . In the first place, not all sensible assertions in the language of the system can be deduced (or disproved) from the axioms: no set of axioms can be complete. And in the second place, an axiomatic system can never be guaranteed to be consistent . . . An axiomatic system cannot be made to generate a description of the world which matches it fully, point for point; at some points there will be holes which cannot be filled in by deduction, and at other points two opposite deductions may turn up.

This has practical implications in formulating fishery management plans. Models used to prepare these plans can always be criticized as being either logically inconsistent or incomplete. Take, for example, the salmon management plan prepared by the Pacific Fishery Management Council. Criticisms of this plan showed considerable dissatisfaction with the socio-economic information available and the degree to which socio-economic data were taken into account. Criticism indicated that the plan was incomplete. The council undertook studies to resolve this alleged incompleteness.

Was incompleteness the problem? If more socio-economic data were gathered, would questioning of the salmon management plan have stopped? Questions raised of the salmon management plan came from professional salmon trollers who were targeted by the plan to lose some of their fishing season. The objective in cutting the troller's season was to meet salmon escapement goals and to ease the management burden between inside and outside fishermen.[1] Trollers questioned these objectives. Starting with different objectives, trollers took advantage of the weakness of any management plan; that it is incomplete.

Trollers also made the point that the plan's logic was inconsistent. "Why," they said, "was the season of only commercial trollers reduced when various types of sports anglers also fished offshore for salmon." The council sought to study this question, too. Answers obtained from more studies, however, are not a solution. Trollers disagree with the plan's objectives. They see the salmon management plan as directed at reducing their catch, and they will continue to attack any plan for being inconsistent or incomplete as part of a political approach to reducing management impacts on their livelihood.

Inventive political activists can always invent new data to be required or find inconsistencies in a management model or plan's logic. The range of questions is only limited by the opponent's imagination. No amount of study and no model, no matter how carefully conceived can resolve these conflicts over management objectives.

Model versus Public Objectives

To construct a model requires accepting certain basic assumptions about the system being modeled. These assumptions and how logical statements in the model are related, mean accepting certain objectives and cultural values. No model, then, is free from cultural values in which certain objectives are accepted as good.

Take, for example, the biological concepts maximum sustained yield, total allowable catch, allowable biological catch, etc.; they are based on a conservationist objective of wise resource use without waste. The use of these concepts also implies that people prefer that the amount available be relatively consistent. This reflects the fact that in resource management we do not like noisy, i.e. highly variable systems.

By contrast a preservationist objective, one which sees a particular creature as valuable solely for its place in an ecosystem, would oppose catching that creature. To preservationists, the logic of sustained yield is inconsistent with their objectives. No amount of data showing that a preferred population is not threatened by biological or commercial extinction will be satisfactory. Ecosystem preservation is part of the conflict over killing whales, seals and sea lions, and the tuna-porpoise problem.

Preservationist-conservationist conflicts are one illustration of differently weighted objectives which alter management situation evaluations. Another is pulse fishing. Pulse fishers can only expect to be on the fishing grounds a short time, before being excluded. They have no incentive to take a long look into the future and will attempt to take as much as possible as quickly as possible. Pulse fishing, however, becomes illogical when viewed from the longer term objectives of a conservationist.

Objectives are weighted differently in economic models used for fisheries management policy. A maximum net economic yield model, as applied to fisheries, emphasizes the objective of profit maximization by individual firms.[2] When this model is applied to a fishery, the management objective is maximizing economic rent to society. Maximum economic rent occurs, as does maximum profit, at the point where the marginal cost of adding one more fishing unit equals the marginal return which can be gained from this additional exploitation of the resource.

The maximum economic yield model is complementary with objectives of resource conservation, profit maximization by individual firms, and assuming free-market competition, should provide competitive prices to consumers. Observing the behavior of Oregon commerical salmon trollers in 1972 shows the majority were not profit maximizers. Economic evaluations by Liao and Stevens (1976) and Lewis (1973) indicate that most Oregon commerical salmon trollers fished at a loss. When asked why they fished, they reported "because fishing was an avocation, something which was a source of pleasure; fishing provided subsidized recreation; fishing was an option with great personal freedom, a chance to be one's own boss; fishing was a way to keep busy during retirement; commercial fishing provided a way to get rid of fish, so you did not have to eat all that you caught; fishing helped solve (sometimes aggravated) physical and mental health problems; fishing was an escape from urbanism; fishing was a form of relaxation; and fishing was a complete experience" (Smith 1974a:374).

Conceptually, these values derived from fishing commercially indicated that fishermen's perceived returns exceeded dollar returns. On the cost side, perceived costs were below dollar costs.[3] This is because when deciding whether to fish or not such costs as depreciation, opportunity costs of management, labor and capital were not taken into account. This reduced perceived fishing costs relative to the dollar costs. The difference in perceived versus actual costs and returns would increase fishing effort. Rather than fishing effort peaking at the point where total dollar returns equaled total dollar costs (E_1), effort would expand to the point where total perceived costs equaled total perceived returns (E_1') [Figure 1].

In terms of an economic efficiency objective, this level of fishing effort indicates that the commercial troll salmon fishery is labor and capital intensive. A limited entry program is one solution to this problem, but if one were implemented, how should the amount of rent extracted be calculated? Using dollar costs and returns will not adequately reduce fishing effort. Total dollar costs plus rent (E_2), on the perceived cost and return curve, only reduces effort to E_2'.

The implication of an economic efficiency model is that the primary output from commerical salmon fishing is food production. Should who consumes the salmon be a management consideration? Domestically sold salmon is a luxury food, it is not found in the diets of most U.S. citizens. Clearly there is not enough salmon to provide it as a food item competitive with chicken, beef, or other staples. If salmon is consumed by people who are already well-off, is it appropriate for fishery management plans to reduce the costs of food production for luxury food consumers? Will the benefits of more efficient luxury food production be distributed widely within society? Is distribution a relevant management objective or is it subsumed in the economic efficiency model?

Concern for an economic efficiency objective is not new to the salmon fishery. In the Columbia River salmon fishery, for the last 100 years, fishermen, processors, and those associated with the industry recognized that there were more fishermen and processing plants than were needed to harvest salmon economically (Smith, in press). The editor of the Weekly Astorian, commenting on the poor financial success of the 1887 season, recommended "to cut down the number of boats in the river at least one-half just as many salmon would be caught as under the present ruinous way of carrying on business." In 1896 the Columbia River Fishermen's Protective Union tried to negotiate, as part of a strike settlement, a plan which would reduce the number of fishermen. The union wanted the cannerymen to take the twine for knitting nets away from the "floating element of the craft, who have no home ties in the city, and who only come during the season to work." At this time the salmon fishery was Oregon and Washington's third largest industry. It provided industrial workers low cost food. It had to compete with beef and other meats. If there was a time when economic efficiency should have been a primary consideration, this was it. Yet it was not.

Why were maximum economic yields not achieved? Actually fishermen did try to solve this problem, and they were partially successful. Fishermen sought through ballot measure elections, the first was in 1908, and other means to exclude various fishing gears (Smith 1974b). The gears excluded, however, were typically the most economically efficient and company owned gears. Excluded were fishwheels, traps, and haul seines. Most fishwheels and haul seines were owned and operated by canneries. Except on the Columbia River, traps, too, were company gear. Each ballot measure decision was reached through the joint efforts of fishermen and the public. Decisions were labor and capital intensive.

With these decisions, then, the public chose to dissipate the potential economic rent in a labor intensive, overcapitalized fishery. Public decisions have achieved neither conservation (Johnson, Merrell, and Schoning 1948) nor economic efficiency objectives (Crutchfield and Pontecorvo 1965).

Observations of Oregon's commercial salmon fishery suggest that fishery participant behaviors and related public decisions were inconsistent with economic efficiency objectives. First, a majority in the salmon fishery did not act like profit maximizers. Second, other values than providing food to consumers were being met. Those consuming salmon domestically were tourists and those who were well-off. Finally, public decisions have been to create a labor and capital intensive fishery rather than one which was most efficient in food production.

Public Participation

If it is true that any optimum yield model can be faulted for being either incomplete or logically inconsistent, and if it is true that the objectives of the economic efficiency model are sometimes counter to the pattern of public decision-making, then how are models and management plans to be constructed? The first thing is to recognize that optimum yield can only be defined in terms of a set of objectives. Second, each objective's importance to society has to be assessed.

As Figure 2 shows, objectives are a prerequisite for plan formulation. Plan formulation can begin at any stage, but in setting and weighting objectives public input is crucial. The figure indicates two points for public input. One is in "specifying relevant objectives" and the other is "review and revision."

A more intensive and aggressive public participation program is required than the current public hearing requirements (Appendix A). Hearings are mainly for the public to review policies, plans, and programs which have already been worked out based on a set of objectives. The public needs to be involved in formulating objectives. Modeling would be most helpful in "formulating alternative plans" and in "analyzing differences among alternatives." Rather than investing heavily in studies to obtain more information, regional fishery management councils might make a better investment in developing processes for broader public participation to define and weight objectives which regional fisheries can serve.

A public participation approach is not without its costs. The major cost is time. It is a slow process. Developing public interest and finding people willing to participate is difficult and frustrating. The alternative of going ahead also has its costs. By proceeding without a clear definition of objectives the probability is raised that those who are offended by the plan will use administrative procedures, the courts, ballot measures, and any other means available to slow down plan acceptance. Public participation is not a conflict-free process. There always will be controversial objectives. Public participation can, however, help clarify these. It can help in the definition of conflicting positions, and depending on the way the process is conducted, public participation may be useful in working out compromises over which objectives are to receive precedence.

In a public participation process, regional fishing management councils could develop a base of political support, or at least, determine public reactions to a variety of objectives. People's reactions can be useful in determining what data to gather, and for objectives where there is conflict, people are often quite resourceful in providing data in support of their position. These data are biased, but understanding the biases under which they were gathered and presented can render them useful.

Creating a public forum, for identification and selection of objectives, forces each user group to present their case to the public. In a public forum there is the risk that some arguments may not win acceptance. This is because fisheries management is not an independent and isolated issue. Fisheries must compete with other uses of increasingly over committed resources. Pacific salmon management, for example, is intimately tied up in the uses to be made of the Columbia and Fraser Rivers, along with numerous other salmon producing streams. The Columbia River serves electricity customers, manufacturers, irrigators, recreationists, and a variety of other people, in addition to numerous types of salmon fishers. Land and riverine planning can have dramatic impacts on most fisheries. One of the pressures leading to the British Columbia limited entry program was competition over allocation of Fraser River waters. River basin developers challenged that the salmon fishery was being subsidized by the Province. In doing this they placed an economic efficiency objective on the salmon fishery (Campbell 1977).

Participation versus Production Fisheries

One value of modeling is the ability to show results attained by varying decision-making parameters. Since each model contains its own basic assumptions and objectives, models based on different sets of objectives, too, should be considered.

I have shown how behaviors of many commercial salmon fishers and the public differed from an economic efficiency model. Are these fishers and the public wrong? Is the model wrong? Neither is the case! The public and the model each define and weight objectives differently. Both can be criticized for being logically inconsistent and incomplete.

For example, Bishop criticizes the economic efficiency model's incompleteness. According to Bishop (1973), it does not take into account the immobility of fishermen and the social costs of their exclusion from the fishery. From a property rights perspective, economic efficiency is inconsistent because it fails to consider "collective or governmental activity in all its ramifications on the choices individuals make" (Randall 1975:734, Furubotn and Pejovich 1972:1137).

Ciriacy-Wantrup and Bishop (1975) criticize the economic efficiency model for being logically inconsistent. Drawing on data from anthropology, that describe the nature of common property institutions in tribal societies, and historical data, that describe the English commons, they argue that social institutions have been effective in preventing depletion of many common property resources. They conclude, "The theory of common property resources, as interpreted in the economic literature, is an inadequate conceptual tool for the solution of such problems."

In terms of economic efficiency objectives, public actions in salmon management are inconsistent with efficient salmon production. Public actions do not seem to favor a food production fishery, maximizing economic yields. Instead public actions optimize participation. With participation, the public has chosen to dissipate the potential rent in increased participation. From the point of view of food production, the decision is unwise because it is economically inefficient. But is economic efficiency the only public policy objective? Do all fisheries have to be managed for the same objectives?

Since public actions affecting salmon management policy have been made regionally, I would expect public interest to have a regional bias. A maximum economic yield model maximizes benefits to society, not just one region. If most of the salmon harvested can be sold outside the region and the region benefits from the income generated by inefficient salmon production, is it unreasonable to assume that the people of a region might attempt to capture the dissipated rents for themselves? One way to capture these benefits would be in higher rates of participation in the fishery than would be optimal from an economic efficiency point of view. Would an Oregon coastal community favor limited entry, when such a program would limit the community's ability to capture expenditures by many inland based salmon trollers, who purchase equipment and supplies in the community during the salmon season?

If salmon is primarily a luxury food, if the benefit of the salmon fishery to society is in values other than food production, and if biological extinction and damage to the ecosystem can be prevented by managing salmon escapements and hatchery production, should a participation objective be considered? On the other hand, if dragger caught fish can make a substantial contribution to lower food prices for a broad range of consumers, is an economic efficiency objective more important?

The implications of the above are that food production and participation in a fishery are not complementary objectives. If the objective is to have many people participate, then economically efficient production is sacrificed. If the objective is economically efficient production, then not everyone can participate. No matter what the management plan, some people will gain advantages while others will share disadvantages. Where economic efficiency rewards the profit maximizer, this person is hurt in a participation fishery.

To understand who are the ones benefitted and who are the ones injured by management, the fishery must be understood as a social system. In order to simplify the fishery as a system for modeling purposes, the individuals who participate are lumped into role categories, e.g. fisherman, processor, buyer, wholesaler, retailer, consumer, manager, etc. The concept of role is both a useful abstraction and a political trap. As a helpful abstraction, it is a way of simplifying and categorizing individual behaviors.

The role concept becomes a political trap when the roles are too general and simplistically defined. The British Columbia limited entry program had early problems because it did not differentiate the role of Indian fisherman. Indians were easily exploited by the profit maximizers whom the limited entry program sought to encourage. The result was that special rules were required for Indians to help preserve their lifestyle. Likewise the British Columbia program did not initially recognize the innovativeness of profit maximizers who soon discovered that small boats could be replaced with large superseiners. In fact in terms of fishing capacity, capital investment increased (Mundt 1974:49).

My point about the role concept's political liability is more than just the need to understand more clearly the people in a fishery and the incentives which drive them. In addition, decisions based on abstractions about role behavior have to be translated into individual actions. British Columbia and Alaska both established grievance procedures by which individual cases were reviewed on their merits. Any modeling approach to fishery management has to incorporate this sensitivity to individual needs and differences.

Those most likely to be injured with a management plan which emphasizes participation are professional fishermen. In Oregon, commercial salmon fishing is a participation fishery. Would the public more readily support incentives which encourage profit maximizing professional fishermen to leave the salmon fishery, than it would be to eliminate, through a limited entry program, inefficient salmon producers? Of Oregon commercial trollers in 1972, about 10 percent were professionals. Since professional fishermen have a profit maximization goal, in a participation fishery, they are the ones who might be encouraged to move into fisheries where this objective can be more effectively met. This has been the pattern for many. Starting in the salmon fishery, successful fishermen have moved into other fisheries where the profit maximization opportunities were greater.

In a participation fishery, people need to be warned that management regulations designed to conserve the resource will restrict their gear efficiency. Overcrowding is likely, and incomes are not likely to be adequate to support oneself solely by commercial fishing. In fact the income distribution in a participation fishery will be very lognormal (Appendix B). The social meaning of a lognormal income distribution is that the majority will have incomes less than the average, while a very few will attain incomes well above the average.

I have assumed in this discussion that people's actions in natural social settings can be evaluated to determine their objectives. The objectives observed in public actions relative to the Oregon commercial salmon fishery are different from the objectives in the economic efficiency model. A process of public participation is suggested for people to identify and weight these objectives, or suggest other objectives which might imply new models. Implied is that without public support the regional fishery management councils will be less successful than with it. The councils will not fail. Their success, however, will be related to the level and quality of public interest and commitment to their management programs.

NOTES

1. Inside fishermen are primarily Columbia River and Puget Sound Indian and non-Indian net fishermen. Outside fishermen are trollers and ocean recreation anglers.
2. For the economic efficiency model applied to fisheries see Gordon (1954), Scott (1955), Crutchfield (1956), Christy and Scott (1965), Crutchfield and Pontecorvo (1969), and Bell (1972).
3. In calculating the costs of fishing see Frederick J. Smith (1973a, 1973b, and 1976). This analysis is based on personal observation and interview of commercial salmon trollers.

REFERENCES CITED

Bell, Frederick W.
1972 Technological Externalities and Common Property Resources: An Empirical Study of the U.S. Northern Lobster Fishery. Journal of Political Economy 80:148-170.

Bishop, Richard C.
1973 Limitation of Entry in the United States Fishing Industry: An Economic Appraisal of a Proposed Policy. Land Economies 49:381-390.

Bronowski, J.
1966 The Logic of the Mind. American Scientist 54:1-14.

Campbell, Blake
1977 Seminar to Department of Agricultural and Resource Economics, Oregon State University, March 31.

Christy, Francis T., Jr. and Anthony Scott
1965 The Commonwealth in Ocean Fisheries. Baltimore, the Johns Hopkins Press.

Church, Alonzo
1936 A Note on the Entscheidungsproblem. Journal of Symbolic Logic 1:40-41 and 101-102.

Ciriacy-Wantrup, C. V. and Richard C. Bishop
1975 "Common Property" as a Concept in Natural Resources Policy. Natural Resources Journal 15:713-727.

Crutchfield, James A.
1956 Common Property Resources and Factor Allocation. Canadian Journal of Economics and Political Science 22:292-300.

Crutchfield, James A. and Gulio Pontecorvo
1969 The Pacific Salmon Fisheries; A Study of Irrational Conservation. Baltimore, Johns Hopkins Press.

Furubotn, Eirik G. and Svetozar Pejovich
1972 Property Rights and Economic Theory: A Survey of Recent Literature. Journal of Economic Literature 10:1137-1162.

Godel, Kurt
1931 Über Formal Unenscheidbare Sätze der Principia Mathematica und Verwandter Systeme I. Monatshefte für Mathematik und Physick. 38:173-198.

Gordon, H. Scott
1954 The Economic Theory of a Common Property Resource: The Fishery. Journal of Political Economy 62:124-142.

Hilbert, D. and W. Ackermann
1928 Principles of Mathematical Logic, 1950 ed., New York, Chelsea Publishing Company.

Johnson, D. R., W. M. Chapman, and R. W. Schoning
1948 The Effects on Salmon Populations of the Partial Elimination of Fixed Fishing Gear on the Columbia River in 1935. Oregon Fish Commission Contribution No. 11.

Lewis, Robert C.
1973 Preliminary Economic Analysis of Management Alternatives for Limiting Harvest Effort by Oregon Commercial Fisheries. Portland, Fish Commission of Oregon, mimeographed.

Liao, David S. and Joe B. Stevens
1975 Oregon's Commercial Fishermen: Characteristics, Profits, and Incomes in 1972. Oregon, Agricultural Experiment Station, Circular of Information, No. 645.

Mundt, J. Carl
1974 Limited Entry Into the Commercial Fisheries, Proceedings of a Conference. Institute for Marine Studies, University of Washington, Seattle.

Randall, Alan
1975 Property Rights and Social Microeconomies. Natural Resources Journal 15:729-747.

Scott, Anthony
1955 The Fishery; The Objectives of Sole Ownership. Journal of Political Economy 63:116-124.

Smith, Courtland L.
1974a Fishing Success in a Regulated Commons. Ocean Development and International Law Journal 1:369-381.

1974b Oregon Fish Fights. Oregon State University, Sea Grant College Program, ORESU-T-74-004.

1976 Intracultural Variation: Decline and Diversity in North Pacific Fisheries. Human Organization 35(1):55-64.

in press Salmon Fishers of the Columbia. Oregon State University Press.

Smith, Frederick J.
1973a Understanding and Using Marine Economics Data Sheets. Oregon State University Extension Service, Marine Advisory Program, S. G. No. 24.

1973b How to Calculate Profit in a Fishing Business. Oregon State University Extension Service, Marine Advisory Program, S. G. No. 29.

1976 The Fisherman's Business Guide. Camden, International Marine Publishing Co.

Tarski, Alfred
1956 Logic, Semantics, Mathematics. Oxford University Press.

Turning, A. M.
1936 On Computable Numbers with an Application to the Entscheidungs problem. Proceedings of the London Mathematical Society 42:230-265 and 43:544-46.

Appendix A: Public Participation

Procedures for public involvement vary with the situation. References discussing some public participation approaches are listed below. Much of the work on public participation has been associated with water resources development and planning. Because of fishermen's mobility, work patterns, and scattered residences, they pose some unique problems for involvement in fisheries management. A public participation process for fishery management planning, however, should not be limited to fishermen as participants, but it should attempt to involve a broad range of public interests.

There is no one method or universally successful public participation process. Procedures have to be adapted to the specific situation. Techniques used can include conferences, seminars, workshops, hearings, decision-making games, advisory committees, questionnaires, surveys, etc. Media used include newspapers, radio, television, film, slide and tape-cassette presentations, brochures, displays, etc.

Usually those whose self-interest is directly affected by the planning activity will participate. People not directly affected by the plan are more difficult to involve.

The most important ingredient for an agency seeking to encourage public participation is a sincere desire for this input. The public readily assesses the agency's objectives and will not be receptive to being used only to further agency objectives.

Public participation is often characterized by strong emotions.

Emotion is one of the driving forces which gets people to participate. Emotionalism connotes acting with strong belief in a limited set of objectives. Lacking emotional commitment to an idea or action, people would not commit their time, energy, or resources. For the participants, public involvement can be a costly process. It takes time away from other activities; it often requires the investment of personal resources.

References

Bishop, Bruce
1970 Public Participation in Water Resources Planning. Alexandria, U.S. Army Engineer Institute for Water Resources.

Borton, Thomas E., Katharine P. Warner and J. William Wenrich
1970 The Susquehanna Communications-Participation Study, Selected Approaches to Public Involvement in Water Resources Planning. Alexandria, U.S. Army Engineer Institute for Water Resources.

Davis, Adam Clarke
1973 Public Participation in Water Pollution Control Policy and Decision Making. Water Resources Research Institute, The University of North Carolina.

Fulton, Jerome K.
1971 Development and Evaluation of Citizen Participation Techniques for Inland Lake and Shoreland Management. Ann Arbor, Huron River Watershed Council.

Moguluf, Melvin B.
1970a Citizen Participation: A Review and Commentary on Federal Policies and Practices Urban Institute Report 102-1

1970b Citizen Participation: The Local Perspective. Urban Institute Report 138-5.

Moffett, Toby
1971 The Participation Put-on, Reflections of a Disenchanted Washington Youth Expert. New York, Dell.

Natural Resources Journal
1976 Papers from Symposium on Public Participation in Resource Decision Making Natural Resources Journal 16(1).

Ragan, James F., Jr.
1975 Public Participation in Water Resources Planning: An Evaluation of the Programs of 15 Corps of Engineers Districts. Fort Belvoir, U.S. Army Engineer Institute for Water Resources.

Ross, Peggy J., Barbara G. Spencer and John H. Peterson, Jr.
1974 Public Participation in Water Resource Planning and Decision Making Through Information - Education Programs: A State-of-the-Arts Study. Water Resources Research Institute, Mississippi State University.

Voth, Donald E. and William S. Bonner
in press Citizen Participation in Rural Development. Southern Rural Development Center, Mississippi State University.

Warner, Katharine P.
1971 Public Participation in Water Resources Planning. Environmental Simulation Laboratory, School of Natural Resources, The University of Michigan.

Water Resources Scientific Information Center
1976 Public Participation in Water Resource Development: A Bibliography. Washington, D.C., U.S. Department of the Interior.

White, Gilbert F.
1973 Public Opinion in Planning Water Development. In Environmental Quality and Water Development, Charles R. Goldman, James McEvoy III, and Peter J. Richerson, eds. San Francisco, W. H. Freeman.

Chisholm, Joseph
1976 Public Participation in Environmental Policy, An Annotated Bibliography. Department of Landscape Architecture, University of Illinois at Urbana-Champaign.

Connor, Desmond M.
1977 Constructive Citizen Participation: The Development and Selling of a Concept. Social Impact Assessment 13/18:8-16

Appendix B: Distribution Analysis

The shape of income or catch distributions can be managed as can the total income or catch. For food production fisheries, catch and income distributions which approach the shape of a normal curve are most desirable. For participation fisheries, lognormal distributions are acceptable.

The basis for these distribution objectives is that in a food production fishery adaptability of food producers is most important. The population of food producers should be able to adjust to environmental, market, technological, and any other changes which might affect their productivity. I am assuming that a normally distributed population is most adaptive.

In a participation fishery, the largest number of participants are desired. Participation is maximized when the mode falls below the average, i.e., a large number of people are unsuccessful in catching fish, while a very few people are highly successful. This assumes that the society does not benefit from the catching of fish, but that the benefit is in the act of fishing.

To monitor the shape of catch or income distributions, a number of statistics are available. My recommendation is to use the method of moments which involves calculating the first four moments of a frequency distribution. The third and fourth moments, skew and kurtosis, are unit free indicators of a frequency distribution's shape. A normal distribution has no skewing, i.e., skew equals zero, and kurtosis is 3.0. For catch and income distributions plotted from low to high, positive skewing and kurtosis values above 3.0 indicate lognormality.

Table 1 provides data for several fisheries. Note that the Columbia River salmon fishery 1899 and the Oregon Otter Trawl fishery 1966-72 have skew and kurtosis measures closest to normality. Troll salmon and recreation salmon angler distributions show the greatest skewing and kurtosis, i.e., departure from normality. The distribution of income and catch for salmon trollers and recreation anglers are not desirable if these fisheries are to be managed as food production fisheries. As participation fisheries, these values are acceptable.

---

1. For more discussion on the background for these measures see Smith (1976).

Table 1.
Gross Income Distributions in Oregon Fisheries

Fishery	Period	Skew	Kurtosis
Otter Trawl	1966-72[1]	0.68	2.90
Columbia River Gillnet	1899[2]	0.62	3.70
	1916-26[2]	0.94	4.07
	1971[3]	1.78	6.87
Troll Salmon	1971[3]	2.58	11.44
Recreation Salmon Angler	1973[4]	8.61	14.98

1. Average calculated from data gathered by the Oregon Otter Trawl Commission.
2. Calculated from fishermen's account books located in MSS 1699, Oregon Historical Society, Portland.
3. Data and calculations from Joe B. Stevens, Department of Agricultural and Resource Economics.
4. Number of fish per angler. Calculated from data gathered by the Oregon Department of Fish and Wildlife.

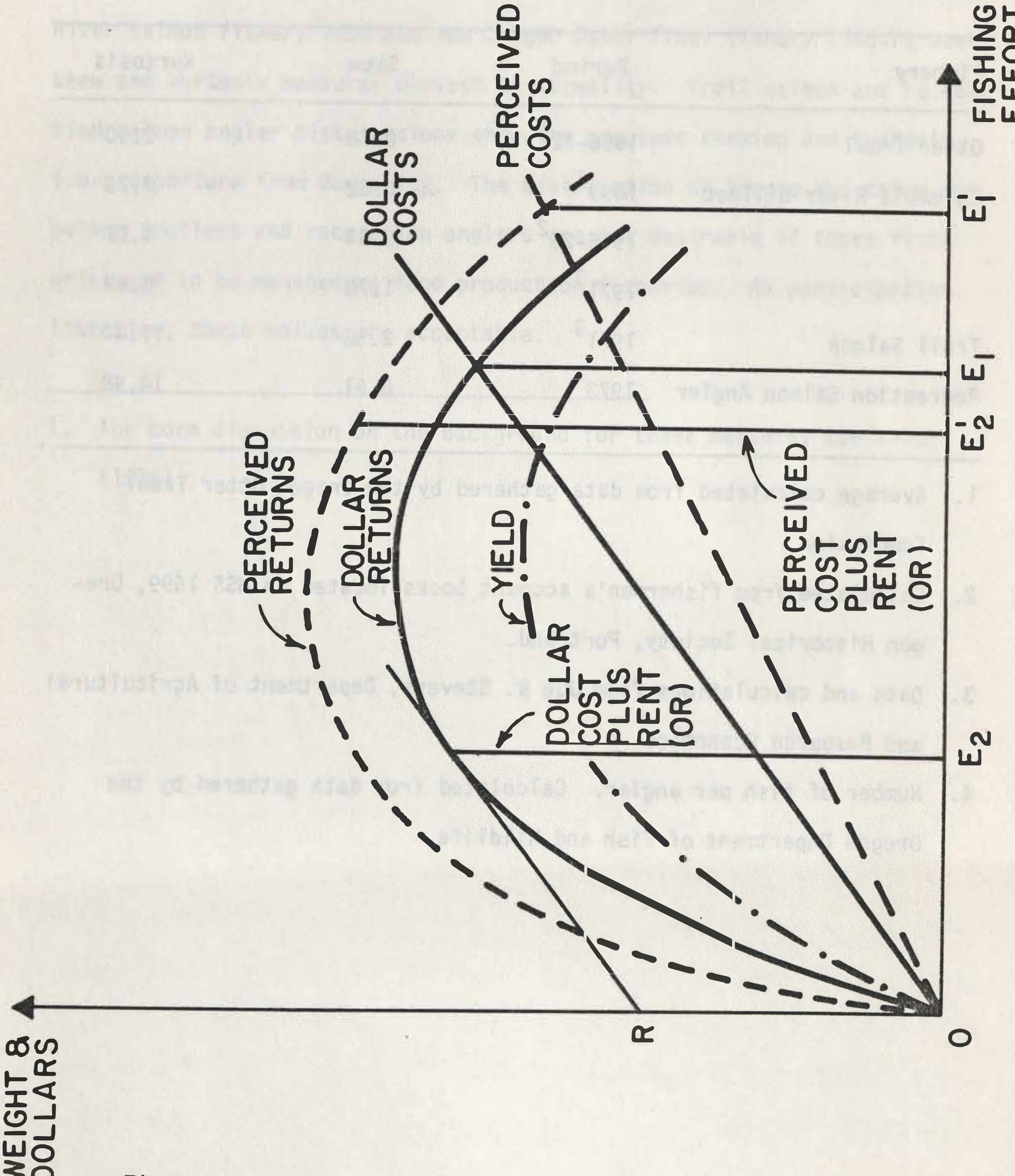


Figure 1--Perceived and Dollar Costs and Returns
(based on Crutchfield and Pontecorvo 1969).

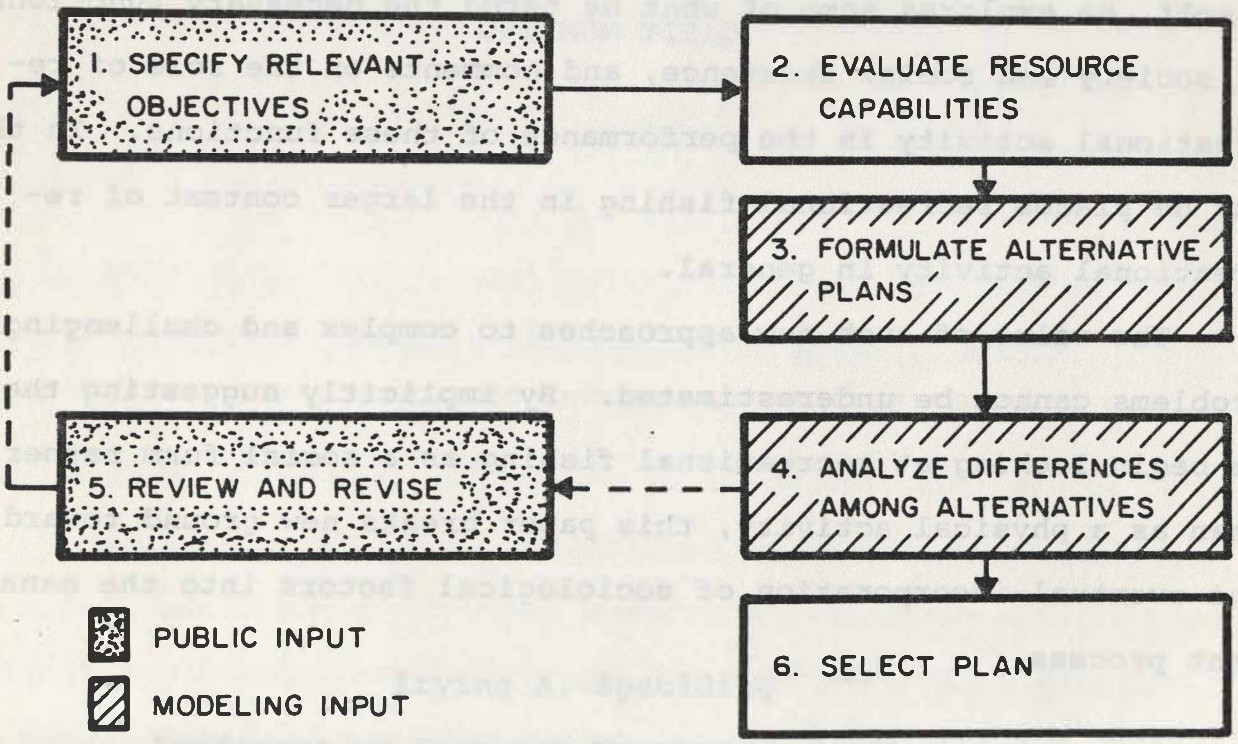


Figure 2--Public and Modeling Inputs in the Planning Process (adapted from Water Resources Council, Principles and Standards)

The necessity for the careful consideration of recreational fishing in our fishery management process is clearly established. What is considerably less clear, however, are the factors which we must consider and the manner in which we can incorporate them into management decisions.

Irving Spaulding approaches this problem with a rigor, depth, and degree of detail unusual in the realm of recreational fishing analysis. Rather than describe and analyse recreational fishing itself, he explores some of what he terms the necessary functions of society and social existence, and comments on the role of recreational activity in the performance of these functions. In this way he places recreational fishing in the larger context of recreational activity in general.

The value of such new approaches to complex and challenging problems cannot be underestimated. By implicitly suggesting that we begin looking at recreational fishing as a social form rather than as a physical activity, this paper breaks new ground towards the eventual incorporation of sociological factors into the management process.

SOCIAL FACTORS RELEVANT TO MARINE RECREATIONAL FISHING
AND
OPTIMUM YIELD

Irving A. Spaulding

Professor or Resource Economics and Sociology

University of Rhode Island

SOCIAL FACTORS RELEVANT TO MARINE RECREATIONAL FISHING AND OPTIMUM YIELD

SECTION I

THE ORIENTATION

The Fishery Conservation and Management Act of 1976 (Public Law 94-265) mandates coordinated consideration of food production and recreational opportunities in the implementation of a long-range program designed to sustain an optimum fisheries yield within the 200 mile territorial limit established by that Act. The basis for the ideas I shall present to you is Chapter I; Section 3, Definitions:

(18) "The term 'optimum', with respect to the yield from a fishery, means the amount of fish ---

(A) which will provide the greatest overall benefit to the Nation, with particular reference to food production and recreational opportunities; and

(B) which is prescribed as such on the basis of the maximum sustainable yield from such fishery, as modified by any relevant economic, social, or ecological factor."

The designated concern with food production and recreational opportunities lets us lapse into a customary mode of thought about relationships between commercial and recreational fishing and their conflicts over locations, times, and species. I do not minimize these; handling these conflicts, however, demands policy for management which can best be formulated on the basis of a thorough understanding of each contributor. I suggest that prior circumstances have allowed us to view marine recreational fishing from a limited perspective. Our current circumstances press for use of a broader perspective in viewing marine recreational fishing; the broader perspective will allow us to achieve increased accuracy in evaluating the existing and potential contribution of marine recreational fishing to "the greatest overall benefit to the Nation." I wish to present for your consideration this kind of perspective.

MARINE COMMERCIAL AND RECREATIAL FISHING; SIMILARITIES AND DIFFERENCES

To point out the ramifications of a broader perspective on marine recreational fishing, it is useful to indicate some similarities of marine commercial and recreational fishing and some critical differences between commercial and recreational fishermen.

I would like to identify six similarities of marine commercial and recreational fishing. First, most of the catch of each is consumed by human beings. Second, each has it's supporting services and industries which, through employment and exchange, have consequential effects on local economies. Third, varieties of equipment are used in the pursuit of each. Fourth, varieties of species --- finfish and shell fish --- are used in each. Fifth, each depends to varying extents on more or less migratory stocks of fish. Sixth, there are seasonal and locational restrictions on each activity.

With respect to commercial and recreational fishermen, I would like to cite differences in the type of dependence which each has on fishing activity. In principle, the commercial fisherman is completely dependent upon his fishing activity for his livelihood and his social status; for him, fishing is an occupation. In principle, the recreational fisherman has other bases for livelihood and social status; for him, fishing is not an occupation. His dependence on fishing activity relates to other social and psychological attributes associated with it. One of these is the recreational aspect of the experience; this is, in essence, a matter of tension management, whether or not the activity is structured by the fantasy of play or the rules of gaming, occurring when the fisherman is not committed predominantly to his work. The remainder of the attributes pertain to necessary functions in society which must be performed if a society is going to operate as a sustained and viable social entity. It is with the relationship between recreational fishing and necessary functions in a society that taking a broad perspective on recreational fishing can be achieved; it is with these relationships that most of the following remarks will be concerned.

The following list of necessary functions is used:

1) Securing new members and terminating memberships;
2) Training members to conform and handling deviants;
3) Handling illness and physical limitations of members;
4) Securing usable goods and services and disposing of wastes;
5) Stabilizing and altering members' positions within the society;
6) Affirming the identity of members and of the society;

7) Managing the society;

8) Accommodating to uncontrolled events.

The first four I regard as having current or future importance for decisions relevant to definition of optimum yield and to allocation of optimum yield between marine recreational fishing and commercial fishing. The last four I regard as having current and future importance as relevant to implementing provisions of the Fisheries Conservation and Management Act of 1976.

Consideration of the above functions in relationship to marine recreational fishing is important since, in combination with that fishing's recreational significance, they provide a basis for:

1) Evaluating what we currently know about number and characteristics of marine recreational fishermen and their fishing activity;

2) Evaluating potential for future development of marine recreational fishing, relative to the number of participating persons, their characteristics, and their use of marine facilities and resources;

3) Evaluating the potential conflict between commercial and recreational fishermen relative to locations, times, and species;

4) Evaluating bases for potential allocation of a portion of the maximum sustainable yield of the fisheries conservation zone to marine recreational fishing in the interest of "the greatest overall benefit to the Nation;"

5) Making management policy and decisions.

SECTION II

NECESSARY FUNCTIONS AND MARINE RECREATIONAL FISHING

Recreation and Necessary Functions

With the following comments, I am attempting to do nothing more than bring into focus a relationship between marine recreational fishing and necessary functions in a manner which suggests their assessment in determining the benefit of marine recreational fishing to the Nation.

Recreational Experience

Recreation is regarded as euphoria-tension managing behavior which takes place when a person is operating without --- or with significantly little --- commitment to the expectations of an institutionalized social role and/or social status. It is among expressions of a "need for variety" which characterizes human beings. In comments which follow, recreation will be assumed to occur concurrently with some degree of achievement relative to a necessary function in society.

Necessary Functions: Relevant to Defining Optimum Yield

Securing New Members and Terminating Memberships

With respect to this function set, we need to know if people who engage in marine recreational fishing are maintaining the population of marine recreational fishermen through natural increase and through continuity of this recreational activity in sequences of generations. Hence, we need both familiarity with demographic and vital statistics for these recreational fishermen and familiarity with information relevant to socialization.

With demographic and vital statistics, we need to compare people who engage in marine recreational fishing and people who have comparable occupations and status but engage in other types of recreational activity. Hence, information on birth rates, longevity, occupation, migration, and death rates would be of use.

With use of information on socialization, we need to know how people become marine recreational fishermen, what keeps some people from taking up the sport if they have the chance, how some get motivated to quit the activity, and what keeps some active in it long after others have relinquished it. We need to know the prevalence of each of these types of experience.

In connection with this, we need to know about the extent to which primary group experience --- family and/or peer group --- contributes to continuity between generations in being marine recreational fishermen or to lack of continuity. We need to know how marine recreation figures in the family institution. It can involve single people of whatever age and marital experience; it can involve courting couples, married couples, and couples of varying degrees of institutional and non-institutional commitment to each other.

But we lack information with which to generalize. We are not prepared to generalize about the significance of marine recreational fishing for the young, middle aged, or old single persons who engage in marine recreational fishing or frequent its environs. As far as couples are concerned, we do not know the prevalence of couples for whom it is an activity mutually meaningful and positive in affect, how frequently it is tolerated or rejected by one of a pair, or how frequently it contributes to people's rejection of each other. We are not able to generalize about ways in which couples accommodate their behavior when shore-line interests differ. One may fish while the other stays at home; or the other may use a beach near the fisherman's location. We are not able to generalize about the prevalence of "fish-oholics" and "fish-widows", if justifiable use can be made of these allusions to compulsive behavior and to a patiently waiting, or not so patiently waiting, Penelope. We need to know more than we do about the influence of family relationships and experience with marine recreational fishing early in a person's life on his engaging in the activity recreationally as an adult.

Over all, of critical concern here are relationships among factors associated with becoming a marine recreational fisherman, with ceasing to be a marine recreational fisherman, and with the prevalence of those factors. If one is searching for a way to measure the benefits to the Nation from these events, a combination of techniques may have to be used. A combination of event count, head count, and cost accounting relative to birth, marriage, life, shared and unshared recreation, occupations, migration, socialization, divorce, separation, and death for people who engage in marine recreational fishing could allow for their comparison with people who engage in other recreational activities.

Divergent as the above types of information are, they are critical for understanding how the number of marine recreational fishermen is maintained, increased, or decreased. The number of marine recreational fishermen has bearing on the definition and justification of an allocation of fishery optimum yield to marine recreational fishing.

Training Members to Conform and Handling Deviants

In considering this function set, one is confronted, in part, with questions that pertain to socialization and to the group and cultural contacts one has as socialization takes place. One is confronted with questions about how to conceptualize, and account for the prevalence of, relationships which "tip" a person in the direction of conformity to the ethical norms which are reinforced in law or in the direction of ethical norms which are not reinforced in law. The most plausible explanation lies in a combination of the influence of interpersonal relationships in primary groups and of Edwin H. Sutherland's principle of differential association.

In connection with primary groups, we recognize the influence of the family (mentioned above) and the peer play group. Marine recreational fishing provides a spontaneous or planned activity for peer groups of young people. It is also a basis for excursions and programs of youth groups sponsored by organizations as diverse as sportsmen's clubs, service clubs, religious organizations, public and private schools, and scouting organization. We have traditionally thought of this activity as appropriate primarily for young males; with current trends of masculine and feminine role change as they are, it is easy to visualize young female participants in the future. However, we need to know more than we do with respect to the prevalence of marine recreational fishing as a socializing experience within families and play groups; included among the latter are both informal spontaneous groups and those affiliated with clubs and associations.

In this context, however, consideration can be given not only to the extent to which a marine recreational fishing venture is used as a socializing experience for youth in family and peer group situations. For youth and adults, consideration can also be given to the extent to which marine recreational fishing is the basis for instruction in both parties and public schools. For adults, we can consider the extent to which it is used as an employee "fringe benefit," if not as a reward, in the commercial-industrial world. One can speculate on the extent to which such a venture is incorporated into the annual traditional events of some religious groupings.

There are additional concerns. We do not know how to measure and evaluate either the benefit of "effective" socialization on the side of conforming to the law or the costs of (and/or benefits) derived from non-conformity which develops. One can suggest that, person for person, the value of "effective" socialization is equal to the cost of handling an identified deviant, but let's structure the conceptual orientation to the problem and test the proposition before pressing the point. If reasonable, the premise would, however, be useful in evaluating the benefit from marine recreational fishing as effective socialization for a person who never became identified as a deviant. It would also provide an orientation to use in evaluating the benefit of marine recreational fishing as a rehabilitative activity for identified deviants.

In addition, in rounding out this aspect of the situation, it seems that career contributions to society from marine recreational fishermen who never became deviants would have to be compared with the costs and/or benefits (gains and losses) of traffic in illegal catch, stolen, burned, or scuttled boats, stolen equipment, and insurance frauds. Accurate data pertaining to these areas would be difficult to secure.

The last two points, however, suggest questions about the significance of marine recreational fishing for handling identified deviants. With respect to rehabilitation of deviants, I know of no circumstances in which marine recreational fishing is incorporated systematically into a program of rehabilitation for legally convicted deviants; there seems to be little indication of dependence on marine recreational fishing in this respect.

For the impact of deviants, however, there are implications. Pertinent here are the theft and destruction of boats and equipment, insurance frauds, costs of these infractions, need for security and recovery systems, and the screening effects these influences have on: 1) who engages in what kind of marine recreational fishing; and 2) who establishes and operates marinas and boat yards in what locations. One system of classifying offenses indicates that there are casual petty (nuisance) thefts of boats and equipment, systematic theft by organized groups, owner instigated thefts and insurance frauds, and thefts among boaters themselves. I know of but one reported nation-wide study of theft associated with pleasure boating; newspaper accounts of the study indicate that in 1975 stolen pleasure craft were valued at about $61 million. How much of this might have been associated specifically with marine recreational fishing was not indicated, but assessment of these aspects of the situation would be useful, if not essential, in helping to determine the "greatest overall benefit to the Nation" associated with that type of fishing.

Handling Illness and Physical Limitations of Members

Consideration of this function set again brings one in touch with vital statistics and demographic data. But to the best of my knowledge, we are not able to indicate what types and rates of illness among marine recreational fishermen may be distinctive. We are uninformed, as well, about the extent to which marine recreational fishing is used as a rehabilitative activity for individuals during intervals of recuperation after illness.

With respect to physical limitations of people and marine recreational fishing, we need to know more than we do about how many people with what handicaps find it possible to engage in which kinds of marine recreational fishing; we need to know as well about the circumstances in which they find participation possible. We know little of the actual or potential constructive impact on their lives which marine recreational fishing may contribute.

Germane, also, to this function set are data about marine recreational fishing as a causative factor in illness and as a source of injuries of handicapping consequence.

Assessment of these aspects of the situation seems appropriate in determining "the greatest overall benefit to the Nation" with which to justify allocation of a protion of fishery optimum yield to marine recreational fishing.

Securing Usable Goods and Services and Disposing of Wastes

I shall comment briefly on this function set, for it is apparently one with respect to which people have the greatest degree of awareness and amount of data. The awareness and data, however, tend to concentrate on usable goods and services; relatively little concentrates on disposing of wastes. Consequently, recognition is given to the personal use of most of the catch of marine recreational fishermen; I understand some estimates to indicate that about two-fifths of the total marine fishery catch is taken by marine recreational fishermen. Yet, there is a need for more precise data than we have with respect to the size and variety of the marine recreational fishermen's catch and the uses to which that catch is put. As development takes place and the number of fishermen increases, there is incessant need to update information both on recreational fishing and supporting industries and on their impact on employment and commercial transactions.

Disposing of wastes presents a different facet of the situation; it can involve non-industrial and industrial wastes; it involves questions of scale relative to the number of people whose wastes are subject to disposition. There seems to be little direct relationship between marine recreational fishing and waste disposal for the individual fisherman. Social and technological changes have made it unnecessary in most circumstances, if not impossible, for the individual fisherman to use household wastes, kitchen wastes, or barnyard waste products as baits and lures. However, on a mass production basis, the effluence from sewers of some highly urbanized coastal areas, when deposited in coastal waters, provides a nutrient influential in maintaining a vigorous and numerous fish stock; one hears reports of areas in which game fish flourish. In contrast to this effluence, industrial wastes are apt to be considered more consistently as detrimental pollutants.

This function set, which deals with goods, services, and wastes, poses a problem of major current concern. Despite our concern, we do not know what kind of systematic relationships can be achieved between securing those goods and services and disposing of wastes, as we have customarily defined them. We are hard pressed, in other words, to assess the significance of marine recreatioanl fishing as a simultaneous contributor to goods and services and means of disposing of wastes. If, in these few words, the problem is structured with some degree of accuracy, we may be in a better position than we were to clarify the relationships, to measure them, and to evaluate their significance for policy. The benefits from all aspects of this function set, however, need to be considered in establishing an allocation of optimum yield for marine recreational fishing.

Necessary Functions: Relevant to Implementation

Consideration will now turn from those functions which are predominantly relevant to defining and justifying an allocation of optimum yield to those whose greater relevance is for establishing self-awareness and coordination among marine recreational fishermen. Although pertinent to implementation of the provisions of the Fishery Conservation and Management Act of 1976, these functions have varying implications for defining optimum yield and closeness of relationship to the four function sets considered above. Numerical continuity with the preceding four will be maintained.

Affirming the Identity of Members and of the Society

This is a function which I regard as highly important for marine recreational fishermen. It is critical to establish the identity of our marine recreational fishermen and to know how many they are, who they are, where they are, and what their capability is for co-ordinated action on their own behalf. The first three items have bearing on defining optimum yield.

Techniques of establishing identity vary. In a more simple way of life than that which we now afford, when fish were relatively more abundant than they are now, a person established and affirmed his identity as a recreational fisherman by participation in the activity. He developed a set of attitudes, skills, and a store of knowledge about nature and his quarry; these attributes enabled him to recognize others of a similar bent and to communicate readily and spontaneously with them. To the extent that fishermen shared the values of the experience of fishing, they could be identified as fishermen. While vestiges of this type of relationship may still exist among marine recreational fishermen, it seems feasible that, in the future, establishing a recognized identity as a fisherman may be a bit more complicated than it has been in the past.

I suggest that in the future, a degree of individual identity as a marine recreational fisherman may be established on the basis of any one or combination of four characteristics: 1) participation; 2) licensing; 3) membership in marine recreational fishermen's voluntary associations and clubs; 4) use of publications for marine recreational fishermen.

Information related to these characteristics is pertinent for understanding the collective identity and capacity for coordinated activity of marine recreational fishermen. With respect to participation, there is need for information about the numbers of marine recreational fishermen which exist, their locations, the variety of their fishing activities, their fishing routines, and their socio-econo-cultural characteristics. Licensing gives legal sanction for participation by those for whom such regulation is deemed necessary; licensing can serve ancillary purposes such as revenue raising, securing descriptive information about fishermen and their experiences, specification of rights and obligations, and evaluation of seasonal catch reports when they are available. Information about the numbers and types of marine recreational fishermen's voluntary associations gives an indication of the complexity of coordinated action by these fishermen. Indication of this is also given by the number of sportsmen's publications dealing with topics pertinent to marine recreational fishing and by the number of issues sold yearly, either by subscription or by magazine retail outlets.

These types of information, appropriately communicated, could contribute to developing among marine recreational fishermen both a greater awareness and more precise definition of themselves in the society than they now have and an awareness of their capability for acting in their own behalf. In light of the scope of undertakings ahead, I see both the acquisition of information and development in each of these four areas as essential if marine recreational fishing is to secure an equitable allocation of fishery optimum yield.

Stabilizing and Altering Members' Positions with the Society

Participation in marine recreational fishing as recreation should not, in principle, have bearing on stabilizing or altering a recreational fisherman's status, or position in the society. In other words, as recreation, fishing should not serve as an avenue for social mobility either upward or downward in the social structure; neither should it serve as an avenue for major role change. In addition, it should not serve as a contributor to a fisherman's current status, even though his status may be reflected by the type of recreational fishing in which he takes part and the style with which he does it. This interpretation hinges on a definition of work as any activity which an individual undertakes with commitment to the expectations of an institutionalized social role and/or social status. Evidence which I have had the opportunity to examine indicates that probably people never get away completely from these commitments in their activities, but the degree of commitment is significantly less during recreational activity than during work. To the extent that anybody experiences "pure recreation" he experiences minimal commitment to institutionalized role expectations and maximal commitment to tension managing activity.

Use of this mode of conceptualization in looking at the prevalence of recreational fishemen makes it possible to distinguish among fishermen with varying degrees of work and recreation in their fishing activity. The following types illustrate the assertion:

First, recreational clam diggers who, with family members and/or friends, go clam digging now and then (or regularly) and get enough clams for immediate personal use by the participants; if they secure more than enough for their immediate personal use, they give the excess to friends and acquaintances; if they don't use clam themselves, they give away their entire catch.

Second, recreational clam diggers who go clam digging now and then (or regularly), get more than enough clams for personal use and systematically sell the quantities not retained for personal use.

Third, recreational clam diggers ho go clam digging now and then (or regularly) and sell all they dig.

In the above sequence, there is an increased orientation toward a type of work which has bearing on cash income. In a sense, the third type may be regarded as having a secondary occupation; it can be regarded as one step removed from the commercial fisherman who is completely dependent upon his fishing for a livelihood and social status --- unless he finds it necessary to engage in a secondary occupation.

There are other illustrations. To the extent that businessmen entertain each other with "recreational fishing" for purposes of establishing good will that facilitates more pointed negotiations, they operate with commitment to the expectations of their institutionalized social roles; hence, their activity can be regarded as work, despite the possibility that it is, in most cases, enjoyable work. In a similar vein, the competent recreational fisherman who uses his recreational fishing experience and opportunities as a training ground to increase his knowledge, skill and personal contacts with people who might later afford him employment, in which those skills and his knowledge can be used, is operating with commitment to role expectations (or aspirations) which justifies identification of his activity as work. Social psychologists speak of anticipatory socialization as relevant to this type of situation.

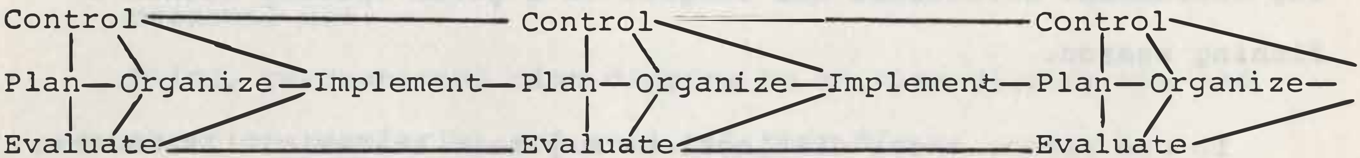
The above relationships are different systems from those associated with prestige which accrues to the individual who wins a fishing tournament or catches the largest of a given species within a fishing season.

In one sense, these distinctions may seem academic. In another sense, they provide perspective on relationships which show ways in which people are dependent on their recreational fishing. In these, the act of fishing is seen as a blend of recreation and work and not as exclusively one or the other. The blend has implications. To the extent that is is more akin to work than to recreation, it can contribute to the stability of people's institutionalized social roles and social status and/or to altering them. Yet, the blend provides opportunity to get things done <u>outside</u> the system of expectations, time frame, and specified localities for institutionalized role performance. The ultimate importance of the blend is yet to be determined. We do not know whether it needs to be handled as a discrete type of activity or whether it can be associated systematically with recreation only, with work only, or with both. My observation is that activities associated with the first four function sets indicated above entail a blend of recreation and work more frequently than not.

Irrespective of the above uncertainty as it may influence data analysis, the blend has importance for marine recreational fishermen in facilitating achievement of goals through use of their individual and collective fishing activities.

Managing the Society

Managment may be considered, broadly, as one major function set. Within its scope, the following sub-functions can be identified: controlling, planning, organizing, implementing, and evaluating. Their continuity can be shown schematically this way:



Implementation of the Act of 1976 is a government responsibility. This is not to be accomplished, however, without taking into account relationships between the public and private sectors of the society. Publicized emphasis on conflict between the two often overides emphasis on their mutual interests and dependence. In relation to this, marine recreational fishermen's voluntary associations have significance and can have more of it than they currently possess. Representing the interests of marine recreational fishermen, these associations can affect decisions and legislation through their contact with government and private agencies; through meetings, publications, and mass media, informed members can be maintained; the associations can be innovative in their actions and proposals for change, or lack of change, which can redound to the benefit of marine recreational fishermen; they can work with government and private industry through policy and law in managing optimum yield for "the greatest overall benefit to the Nation."

Accommodating to Uncontrolled Events

The traditional culture of the seafarer is filled with superstition. Use of superstition is one way of accommodating to uncontrolled events or to inadvertent events with which malevolent results from whatever causes are associated. The ritual behavior that accompanies superstition serves to relieve the seafarer's apprehension and his life goes on.

I am not suggesting that consideration be given to the development of superstition and ritual. Rather, what I have in mind is recognition that climatically, geographically, biologically, and physically there can be long range trends of slow change in environments of man and fish which augur for gradual modification of their behavior and relationships. Concurrently, there can be short range major events of catastrophic proportions which occur outside man's control, or because of his negligence, to which response must be made. One accommodation to these changes and events is to bring them under control; short of having the "know-how" and technology to do this, man needs systematic ways of acting and manipulating circumstances so his life will go on when he is confronted with uncontrolled events. In the case of marine recreational fishing, I have in mind uncontrolled events which might, for example, decimate the prevailing habitat of a species, or interfere with the migration of migratory stocks, or interfere with breeding locations to an extent that would diminish available fishery yield significantly. These kinds of events are capable of modifying the premises on the basis of which any definition of optimum yield may be made. Although the topic is one for extensive consideration, recognition of this potential is adequate for our immediate purposes.

SECTION III

SIGNIFICANCE FOR OPTIMUM YIELD

My concern has been with bringing to our attention a relationship between marine recreational fishing and necessary functions in a manner which would allow for assessment of the benefits of marine recreational fishing to the Nation. My approach is based on a limited number of concepts. Work and recreation are distinquished from each other by participants' degree of commitment to expectations of institutionalized social roles and/or social status; work entails commitment and recreation entails lack of commitment. Commercial and recreational fishermen are distinguished from each other by their dependence on fishing for livelihood and social status; this dependence is, in principle, complete for commercial fishermen and nonexistent for recreational fishermen. However, recreational fishermen are dependent on their fishing activity in other respects. They are dependent on it for diversion from the activity of their occupational roles and management of tensions; they also depend on their recreational fishing for contributions to necessary functions in society. In the achievement of these necessary functions, they probably perform some work, however little that may be, as well as experience recreation.

My major assertion is that the most adequate evaluation of benefits from marine recreational fishing will be made when its contributions to all of the necessary functions are assessed and related systematically. Making this type of evaluation is a task that poses a lot of hard work and frustration in the context of challenge and opportunity. It is a task to be approached by people trained in the range of relevant disciplines and willing to work on an interdisciplinary basis as well as on a multidisciplinary basis.

I also assert that this kind of evaluation, which is relevant to food production and recreational opportunity, will, when made, provide a basis for designating the equity of marine recreational fishing in an optimum yield with a greater adequacy than could be achieved otherwise. Short of this degree of adequacy, we are in circumstances in which decisions must be made and action taken. If action is taken on the basis of the most readily available data and understanding, extensive use will probably be made of information pertaining to the function of securing usable goods and services. This information is pertinent to food production and recreational opportunities. In this area, marine recreational fishing and commercial fishing have some similar characteristics; most of the catch is ultimately consumed and each contributes to the economy in its own right and through supporting industries. If this is the point at which a beginning must be made, so be it. But let us keep in mind that such a move is a beginning move. We will have opportunity to look at food production and recreational opportunities as they pertain to fishery optimum yield with boarder perspective than we have used in the past, to the benefit of our marine recreational fishermen, our commercial fishermen, and the Nation. With this opportunity at hand, let us use it.

FUNCTIONS NECESSARY FOR THE MAINTENANCE OF A VIABLE SOCIETY

A. SECURING NEW MEMBERS AND TERMINATING MEMBERSHIPS

B. TRAINING MEMBERS TO CONFORM AND HANDLING DEVIANTS

C. HANDLING ILLNESS AND PHYSICAL LIMITATIONS OF MEMBERS

D. SECURING USABLE GOODS AND SERVICES AND DISPOSING OF WASTES

E. AFFIRMING THE IDENTITY OF MEMBERS AND OF THE SOCIETY

F. STABILIZING AND ALTERING MEMBERS' POSITIONS IN THE SOCIETY

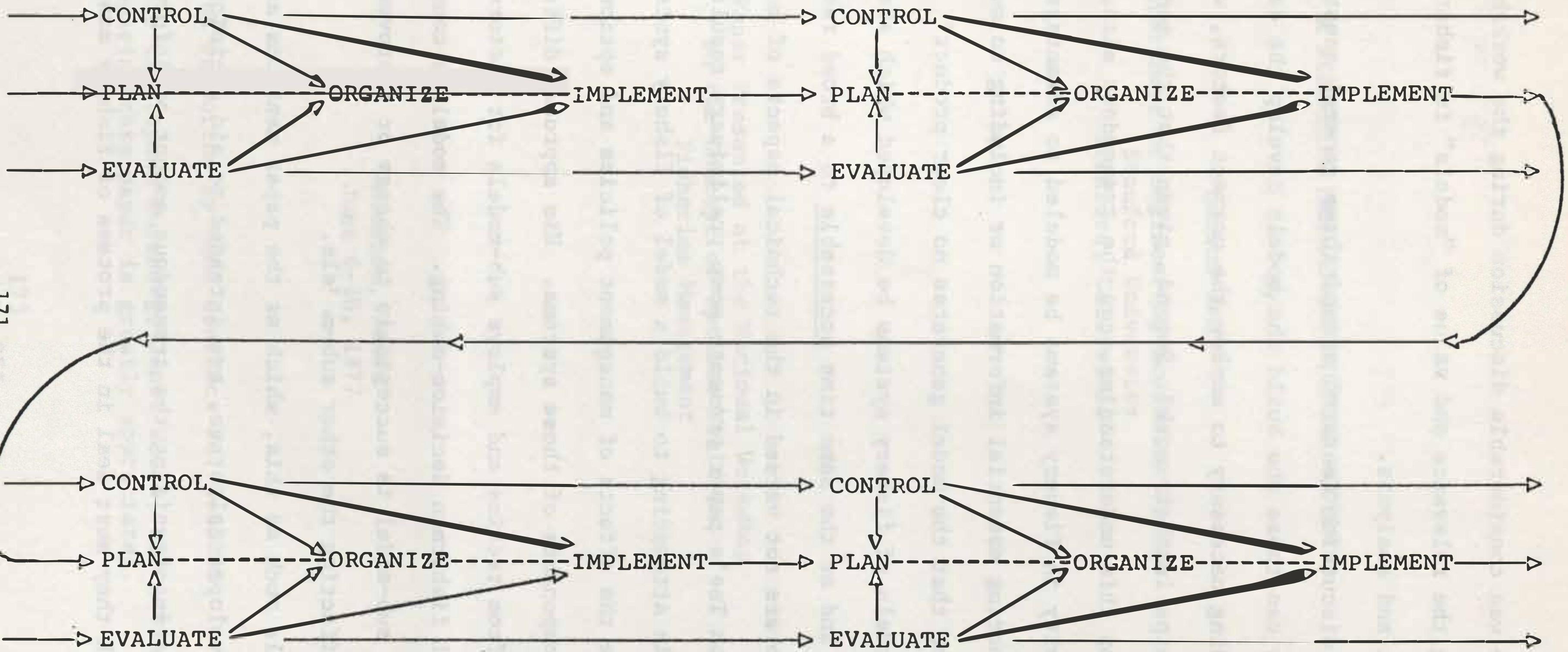
G. MANAGING THE SOCIETY

H. ACCOMMODATING TO UNCONTROLLED EVENTS

6/6-7/77

Irving A. Spaulding

MANAGEMENT SUB-FUNCTIONS



There was considerable discussion during the workshop concerning the relevance and value of "models" in fishery management and analysis.

This discussion centered around three general questions. First, how can those who build the models develop the depth of understanding necessary to employ the correct factors, weights, and relationships in their work? Second, given that the modelbuilder can develop this understanding, can the tremendous size, complexity, and diversity in fishery systems be modeled to advantage without either ignoring essential information or including so much information that the model generates no clear product? And third, how can models of fishery systems be developed which are useful, accurate, and at the same time <u>accessable</u> to a broad range of user groups who are not versed in the technical aspects of modeling?

Edison Tse's paper presents some preliminary results of this research in attempting to build a model of fishery systems which will trace the effects of management policies and options on various components of those systems. His approach differentiates strategy from tactics and employs sub-models for factors such as individual fisherman decision-making. The model is constructed so that each sub-model is succeptable to change or improvement without affecting the other sub-models.

Models such as this, which as the paper mentions are still in the developmental state, are intended to aid decision-makers and others in organizing the tremendous amount of information with which they must deal in the process of fishery management.

A FISHERIES MANAGEMENT SYSTEMS MODEL*

by

Edison Tse**

Department of Engineering-Economics System
Stanford University
Stanford, California

Paper Presented at the National Workshop
on the Concept of Optimum Yield in
Fisheries Management

Houston, Texas
June 6-10, 1977

* Research supported by NOAA Contract No. 6-35296.

** The help of Stephen Wurzburg, Janet Wolfe, and Arvind Khilnani in preparing this paper is greatly appreciated.

ABSTRACT

This paper reports some results of an on-going research project which involves the development of an analytic framework capable of estimating the effects of different fishery policies upon the U.S. fishery system. Some of the impacts considered affect the fish stocks, commercial and recreational fishermen, processors, consumers, fishing communities, and U.S. foreign relations.

The model under development consists of a short term component which describes the seasonal actions of fishery market to determine the price and quantity of fish sold in the market and a long term component which describes possible future structural changes affecting the American fishing industry. The two components are integrated to provide a dynamic description of the fishery system.

I. Overview

Fishery management involves many decisions which have both short term impacts and long term impacts. These decisions affect an environment characterized by complex, uncertain, and dynamic interactions between man and nature. The involution of the environment increases the need to be able to justify decisions and policies by logic and analysis as opposed to merely employing intuition. Our primary goal is to develop an analytic framework which decision makers can employ to approximate the impacts of various policies upon the fisheries system.

The methodology we are employing is the construction of a mathematical model which characterizes the more significant phenomena of the fisheries system and captures the essence of the management task called for by the Act. As such, our model must concern itself with, for example, the fish biomass, the economics of the fishing and processing industries, the social structure of fishing communities, and the habits of consumers. Since most of the feasible management policies affect the harvesting of fish rather than the demand for fish by consumers, our initial effort focuses more heavily upon this aspect of the fishery system.

The model attempts to determine the behavior of these various factors in the aggregate. It thus might presume, for instance, that boat captains stop fishing when they believe that the cost of making another trip will not be offset by the revenues they would receive from the sale of their catch. There may very well be individual boat captains who would continue to fish under such circumstances but, if the fishing fleet as a whole behaves according to the presumed pattern, then the assumptions underlying the model are valid and the model will reflect reality reasonably well. It is for this reason, the aggregation of individuals, that the model will not precisely predict the behavior of the system under various policies. Rather it can best be used to demonstrate tendencies of behavior.

We believe that our "systems model" can be used in the decision making process as shown in the diagram below:

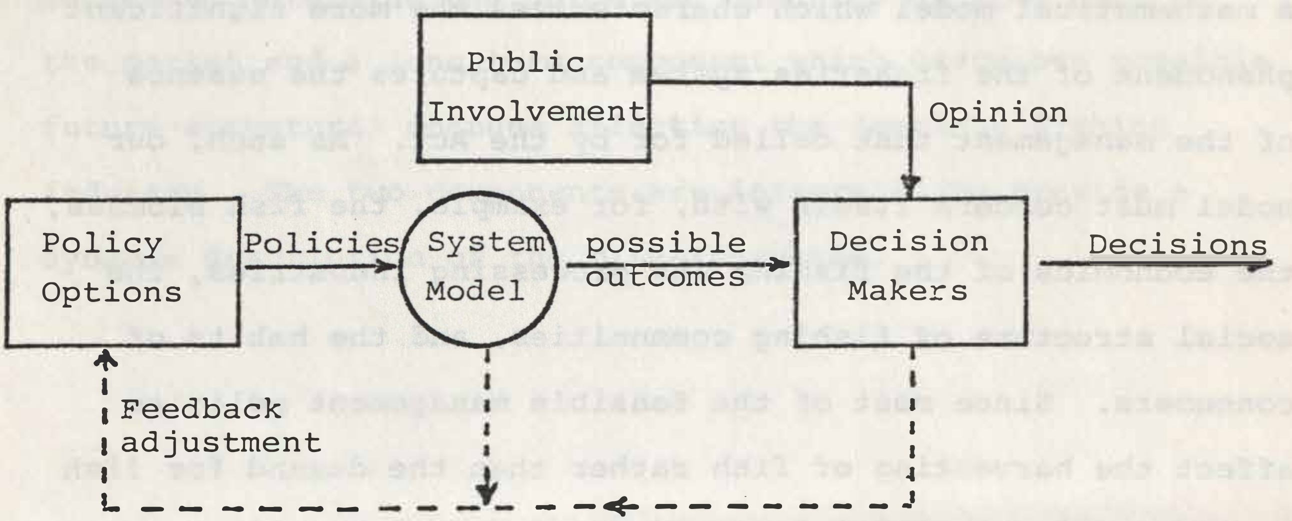


Figure I Use of System Model in the Decision Making Process

Policies might include quotas, limited entry, gear restrictions, insurance programs, etc., while outcomes might include economic impacts to consumers and the fishery industries, social consequences for communities effects upon the fish population, foreign relations, and changes in recreational opportunity. Thus decision makers could formulate alternate policies and use our model to help determine the general effects the policies would cause. They could then use this knowledge, along with their own preferences and public involvement, to make their decisions.

We have purposely attempted to design our model to be as value free as possible. It will not tell the decision maker what the best policies are but rather it will inform him/her of what the effects of his/her decisions will be upon consumers, fishermen, fish stocks, etc. It does not contain any implicit decision criterion such as maximum sustainable yield or greatest economic surplus. Therefore, the decision makers have the responsibility to decide which effects are preferable and which tradeoffs are justifiable. Should the definition of optimum yield be agreed upon, the model can be used to describe the outcomes of various policies which enter into the determination of optimum yield.

One of our major objectives is to design the model to capture the dynamic characteristics of the fishery system as opposed to modeling the system as if it exhibited steady state behavior. This is especially important since both the marine ecosystem as well as the fishing industry are dynamic in nature.

We have also constructed our model out of self contained modules so that it can easily accommodate different behavioral assumptions and increases in knowledge since one submodel can be replaced and updated without affecting the structure of the others. Finally, we have attempted to make our model applicable to a wide variety of policies and environments by using a general structure which can be adapted to many specific circumstances. We believe that these characteristics are extremely important because of the unprecedented nature of the management task called for by the FCMA. There will be a substantial amount of experimentation requiring future adjustments in response to new circumstances and new understandings of the fishery system as it is affected by management decisions under the Act. Thus choices of alternative courses of action must be able to incorporate substantial improvements in the understanding of the fishery system and the effectiveness of different techniques in managing it.

Finally, it should be noted that the model presented in this paper is part of a continuing effort. As such, it does not constitute a final product for changes will undoubtedly be made during the next few months.

II. Model Description

In order to evaluate the full impact of a policy, we must be able to determine its short term as well as its long term consequences. Guided by this need, the model developed consists of two components, the tactical subsystem and the strategic subsystem. The tactical subsystem describes short term phenomenon and is coupled to the longer term strategic subsystem. In the tactical subsystem the prices and amount of fish landed are determined for a season. From this result estimates of vessel profits, fishermen's earnings, consumer benefits, and other relevant measures of outcomes are calculated. The strategic subsystem describes the fish population dynamics, structural adjustments in the fishing industry, and changes in consumer preferences that may occur in the long run as a result of fishery management decisions.

2.1 The Tactical Subsystem

The short term interaction between the biological system and the economic system is summarized in Fig. II.1. The fish are harvested by three different groups: recreational fishermen, domestic commercial fishermen, and foreign fishermen. The catch of one group will influence the landing per unit effort of the other groups because of the common property nature of the fishery resource.

The recreational fishermen interacts directly with the recreational fishing opportunity for if recreational fishing

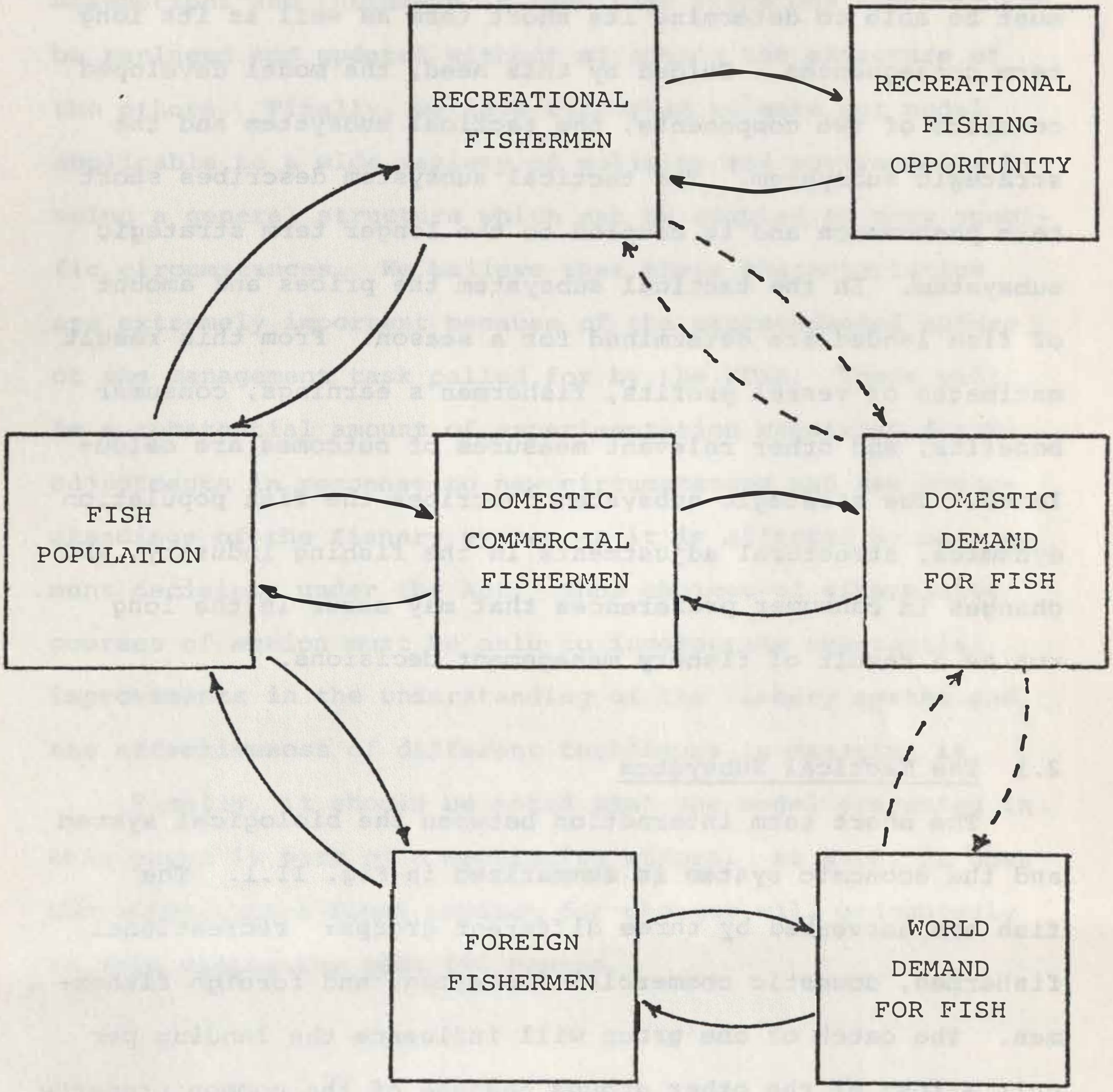


Figure II.1 Short Term Interaction

is more readily available, the recreational fishermen will fish more often and vice versa. The recreational fishermen interact indirectly with the domestic demand for fish since they will presumably buy less fish if they can catch their own. The domestic fishermen, however, interact directly with the domestic demand for fish since almost all of their catch will end up being sold in the market. The foreign fishermen cannot directly land their fish in the U.S., and thus all of their catch is sold in the world market, which will influence, to some extent, our domestic market.

Each of the seven submodels in Figure II.1 consists of a behavioral description of the phenomena within the submodel. The tactical subsystem then integrates the seven submodels through the interaction of supply and demand for fish in the marketplace.

To illustrate our approach we shall describe in Sections (2.1.A) - (2.1.C) a simplified version of the commercial fishing and demand submodels and their short term interaction through the market clearing submodel.

2.1.A Commercial Fishing Fleet Tactics Submodel

The basic feature of this submodel is that it describes how different types of vessels compete in harvesting the same species. Commercial fishermen decide at the start of each fishing trip if they want to go out fishing, so long as a total catch quota has not been filled and the weather is suitable. Factors in the fisherman's decision to initiate a fishing trip include the current state of the fish stocks implied by the catch per effort obtained in recent trips, the current exvessel price, and the operating cost per day of his vessel. From this information, the fisherman can estimate the expected net revenue from a fishing trip. In our model, the fisherman will decide to go fishing only if his expected net revenue is positive.

A mathematical formulation describing the depletion of a fish stock within a fishing season and the decision behavior of commercial fishermen in response to stock availability and price is developed in Appendix A1.

From this model, a relationship between the quantity of fish landed and the average exvessel price is developed. The quantity-price relationship depends on the number of vessels fishing in the fishery, the catching efficiency (fishing power or catchability) of each vessel class in the fishery, the operating cost per boat-day of each vessel class, and the abundance and availability of the fish stock. The model allows one to determine the impact of changes in the stock abundance or the composition and size of the fishing fleet on the supply of fish.

2.1.B Fish Demand Submodel

The price per pround fishermen receive for their landings depends on the magnitude of the catch. When catches are large, the price per pound paid by processors and distributors will be lower than with smaller catches. In the demand submodel this price-quantity relationship, or willingness of consumers to pay for a given quantity of fish, is estimated from historical data and from assumptions as to how consumers behave. The form of the equations used along with the relationships assumed between the exvessel price and quantity and the retail price and quantity are discussed in Appendix A2.

2.1.C Market Clearing Submodel

The exvessel price per pound which fishermen receive depends on the quantity of fish landed and on the demand for fish by consumers. The market clearing submodel finds the price and quantity for which the price-quantity combination calculated by the commercial fishing fleet tactics submodel and the price-quantity combination calculated by the demand submodel will be equal within a given season. The process of finding this market clearing price and quantity can be conceptualized as finding the intersection of the supply and demand functions of price and quantity generated by the commercial fishing fleet tactics and demand submodels. An iterative procedure for determining the price-quantity combination for which the market will "clear" is described in Appendix A3.

2.1.D Extensions

We shall briefly note the extensions we can make on the model described in Sections 2.1.A - 2.1.C and appendices A.1 - A.3.

The multispecies short term interactions can be incorporated into the basic fishing fleet tactics model. Our multi-species extension assumes that fishermen will direct fishing effort at the species providing the highest expected net revenue. Additional factors in the fisherman's decision will include the relative abundance and availability of each species, the relative catchability of each species by his vessel, the expected bycatch of each species, and the relative expected exvessel price of each species. The effect of bycatch as well as directed catch is included in the depletion of the stock due to fishing during the season. The demand model must be extended, at the same time, to handle substitution of one species for another.

The landing model described in Appendix A.1 assumes the fish to be aggregated into one age class. A fish stock population can be disaggregated into various age classes similarly. Such a cohort fish population model allows analysis of the effects of mesh size as well as fishing effort on the age structure and abundance of the fish stock. It also allows variation in the vessel efficiency (catchability) coefficient with fish age (weight). The processing loss factor and the price per unit weight may also depend on the cohort age. Continuous growth as well as natural mortality within a season can be included.

The specific form of the demand function described in Appendix A2 can easily be altered; any price-quantity relationship can be substituted. We are now in the process of developing a demand model which captures the decision behavior of the consumers and processors.

It should be emphasized that our present modeling approach relies heavily upon understanding the decision behavior of the economic agents involved and expressing such understanding in a mathematical system framework that allows us to draw quantitative conclusions.

2.2 The Strategic Subsystem

The Strategic Subsystem describes possible intertemporal structural changes of the fishing system as consequences of various management policies. There are basically three major components in the Strategic Subsystem: the interaction of fish species, investment in the fishery industry, and dynamic changes in demand for fish products. These three components are integrated to provide a description of how the structure of the fishery system would evolve in time.

2.2.A The Fish Population Model

A model of the ecosystem is one of the most important components of the Strategic Submodel. It accounts for the interaction of different species in the ocean, e.g., recruitment, predator-prey relationships, competition for food, effects of current and weather, etc. This model will allow us to assess the effect of a certain fishery management decision on the future stock of different fish species, which is an important element in the evaluation of fisheries management policy. Such a model is expected to be developed by fishery biologists, and our main effort is to integrate this model into our fishery system model so that we can assess the full impact of alternate fishery management decisions.

2.2.B The Investment Submodel

The investment submodel is currently under development. It describes investment in fishing vessels, processing plants, and party boats and other support industry for recreational fishing. One can classify three categories of investors according to their investment objectives: (1) businessmen who desire to invest capital to get the "best" return; (2) fishermen who look at investment in fishery as a means of providing self-employment, and (3) businesses looking for increased vertical integration. Each of these categories of investors use different criteria to decide whether they desire to invest in a fishery related industry.

The submodel consists of two parts. The first part, referred to as a perception formation submodel, describes how certain signals (e.g., price of fish, profitability, etc.)

and the environment (e.g., strict quotas on foreign fishing within our 200 mile extended jurisdiction) influence expectations on investment return and its associated uncertainty concerning a particular investment. Once the perception is formed, another part describes how potential investors will then determine whether they want to invest in the industry. This operates in tandem with a submodel of financiers and their perceptions of the fishing industry since the availability and terms of financing constrain investment opportunity.

2.2.C The Demand Submodel

The demand for fish is now undergoing a rapid dynamic change due to the introduction of new products like convenience frozen fish products. The advertising campaign of fast food chains, which now sell large volumes of fish products, account also for this rapid change in consumer preference for fish. A model describing how advertising, fish quality, and human interaction can influence the number of fish consumers is now under development.

III. Policy Studies

The main effect of a fishery mangement policy is that it may influence the decisions of the economic agents involved: namely the fishermen, processors, and fish consumers. The changes in their decisions will induce changes in the fish supply and/or demand picture which will in turn yield a new market equilibrium. For example, a policy of restricting foreign fishing within 200 miles would probably prolong the domestic fishing period, which would cause the domestic supply of fish to increase. The abundance of fish supply might then cause the processors to increase their effort in marketing the fish product which would influence consumers' preference for fish. On the other hand, a policy which would influence consumers' preferences for fish would induce fishermen to go out to harvest more fish.

Thus we see that a policy may have both direct and indirect effects on the supply and demand of fish. Some policies have a direct effect on the supply side while the others have a direct effect on the demand side. An appropriate policy mix is one which consists of a set of complementary policies such that their effects on the fish supply and demand are coordinated. Further discussions on this can be found elsewhere. [1]

The following methodology was used to demonstrate how the systems model described in Section II can be used in the assessment of policy options. First, a fictitious base was constructed for illustrative purposes. This base case specified a fish population, the numbers of small and large U.S. boats and foreign vessels (along with their efficiencies and operating costs), imports, etc. Next the catch of each vessel type and the U.S. market price for fish was determined for the base case using the systems model. Policies which changed various parts of the base case were then examined using the systems model to determine the resulting division of the catch among vessel types and the U.S. market price of fish. The results for different policies and the base case were then compared.

The first policy examined was restricting foreign fishing within the 200 mile zone. The base case is given in the first column of Table III.1 where we allow no foreign fishing within the 200 mile zone. The second column corresponds to the case where we restrict both the foreign catch quota and the number of foreign boats. The direct effect of such a management policy is that the total domestic catch is reduced because the domestic fishermen have to compete with the foreign fishermen, and consequently the exvessel price of fish is increased. Since most of the domestic catch goes into the fresh fish market, the reduction in supply drives up the price of the fresh fish (from $2.05 to $2.10). The frozen fish price remains the same because we assume that the foreign supply is determined by the world market; and because the total foreign catch within our 200 mile zone is such a small fraction of total world's catch that it does not affect the world market significantly. (This assumption may be removed by building a model of foreign supply and world demand.) The small boats, whose catch is limited by their boat's relatively small capacity, are benefited in this case from the fact that the price of the fish is higher than that for the base case. On the other hand, the large boats receive lower net revenue since the rise in price does not compensate for the reduction in volume when we allow some foreigners to fish within the 200 mile limit. The consumers are worse off since they have to pay a higher price for fish.

The third and the fourth columns illustrate the relative effectiveness of two different policy instruments for reducing foreign fishing: quotas on foreign catch and restrictions on the number of foreign vessels. Comparing columns two and three, we see that when the restriction on the number of foreign boats is unchanged, the <u>increase</u> in the quota on foreign catch does not have a significant short-term economic impact on the overall fishery industry but does change the next year's fish population (based on a simple Schaefer model). On the other hand, the increase in the number of foreign boats, even though the total foreign catch quota remains the same, will have tremendous economic impacts on the fishery system. This indicates that, as a policy instrument, restriction of the total number of foreign vessels is more effective than restriction of total foreign catch. (Of course, if foreign fishing interests responded to restrictions on the number of fishing vessels by increasing their fishing power, then our restriction could be modified accordingly.)

The next set of studies, Table III.2, illustrates the economic impact of restricting the number of domestic vessels participating in the fishery. As such, the results do not imply the workability of limited entry, which is a much deeper issue involving biological, economic, social, and political factors. Rather, this set of studies merely indicates the possible short term economic impact of restrictions on the size of the domestic fleet. One can also view the studies as an indication of what might happen if we have unlimited entry along with a significant amount of investment in new vessel construction.

Column one is the base case; column two represents the case in which the number of large boats is doubled (86 to 172). Since more boats are harvesting the fish stock, the total domestic catch is increased, which drives down the ex-vessel price of fish. The small boats suffer since they are catching less fish than before compounded with the fact that the price of fish is lower. The total net revenue of large boats increases but the net revenue per boat is lower. The consumers are slightly better off since they pay a lower price for the fish.

Column three differs from column one in that the total number of small boats is doubled. Similar consequence as in the previous case can be deduced from the model.

Column four differs from column one in that the large boat catchability is reduced to half of that in the base case. The total catch is reduced, which drives up the ex-vessel price, and the small boats gain termendously while the consumers pay a higher price for fish.

There are many other studies one can make using the present model. A computer program has been developed whereby policy makers can input potential policy options and investigate their impacts, as well as the effectiveness of these options in achieving desired policy goals.

Table III.1

FOREIGN CATCH QUOTA AND VESSEL RESTRICTIONS

Decision Variables				
Foreign catch quota (millions of lbs.)	0.	100.	300.	300.
Number of foreign vessels	0.	100.	100.	200.
Input Variables				
Number of small U.S. vessels	161.	161.	161.	161.
Number of large U.S. vessels	86.	86.	86.	86.
Fish population (millions of lbs.)	700.	700.	700.	700.
Domestic Fish Supply				
Total catch (millions of lbs.)	178.	137.	137.	105.
Catch to fresh market (millions of lbs.)	175.	137.	137.	105.
Catch to frozen market (millions of lbs.)	3.	0.	0.	0.
Catch by small U.S. vessels (millions of lbs.)	32.	31.	31.	31.
Catch by large U.S. vessels (millions of lbs.)	145.	106.	106.	75.
Average exvessel price ($ per lb.)	0.216	0.230	0.230	0.244
Net revenue—small vessels (millions of $)	0.74	0.97	0.97	1.19
Net revenue—large vessels (millions of $)	5.57	5.01	5.01	5.05
Net revenue per vessel—small vessels (thousands of $)	4.60	6.02	6.02	7.39
Net revenue per vessel—large vessels (thousands of $)	64.7	58.3	58.3	58.7
Domestic Fish Consumption				
Total consumption (millions of lbs.)	334.	323.	323.	314.
Fresh fish consumption (millions of lbs.)	47.	37.	37.	28.
Frozen fish consumption (millions of lbs.)	286.	286.	286.	286.
Retail price of fresh fish ($ per lb.)	2.05	2.10	2.10	2.16
Retail price of frozen fish ($ per lb.)	1.44	1.44	1.44	1.44
Consumer surplus (millions of $)	184.	180.	180.	177.
Foreign Effect				
Frozen fish imports (millions of lbs.)	286.	286.	286.	286.
Foreign catch (millions of lbs.)	0.	100.	154.	285.
Biological System				
Total catch (millions of lbs.)	178.	237.	291.	390.
Next year's population (millions of lbs.)	763.	704.	650.	551.

Table III.2

CHANGES IN NUMBER OF VESSELS AND IN VESSEL EFFICIENCY

Decision Variables	0.	0.	0.	0.
Foreign catch quota (millions of lbs.)	0.	0.	0.	0.
Input Variables				
Number of small U.S. vessels	161.	161.	332.	161.
Number of large U.S. vessels	86.	172.	86.	86.
Fish population (millions of lbs.)	700.	700.	700.	700.
Domestic Fish Supply				
Total catch (millions of lbs.)	178.	232.	207.	145.
Catch to fresh market (millions of lbs.)	175.	186.	180.	145.
Catch to frozen market (millions of lbs.)	3.	47.	25.	0.
Catch by small U.S. vessels (millions of lbs.)	32.	17.	66.	47.
Catch by large U.S. vessels (millions of lbs.)	145.	215.	141.	98.
Average exvessel price ($ per lb.)	0.22	0.21	0.21	0.23
Net revenue—small vessels (millions of $)	0.74	0.45	1.23	1.29
Net revenue—large vessels (millions of $)	5.57	6.96	4.37	2.95
Net revenue per vessel—small vessels (thousands of $)	4.60	2.80	3.70	8.01
Net revenue per vessel—large vessels (thousands of $)	64.7	40.5	50.8	34.3
Domestic Fish Consumption				
Total consumption (millions of lbs.)	334.	347.	340.	325.
Fresh fish consumption (millions of lbs.)	47.	50.	49.	39.
Frozen fish consumption (millions of lbs.)	286.	297.	292.	286.
Retail price of fresh fish ($ per lb.)	2.05	2.04	2.04	2.09
Retail price of frozen fish ($ per lb.)	1.44	1.43	1.43	1.44
Consumer surplus (millions of $)	184.	189.	187.	181.
Foreign Effect				
Frozen fish imports (millions of lbs.)	286.	284.	285.	286.
Foreign catch (millions of lbs.)	0.	0.	0.	0.
Biological System				
Total catch (millions of lbs.)	178.	232.	207.	145.
Next year's population (millions of lbs.)	763.	709.	734.	795.

APPENDIX A. THE TACTICAL SUBSYSTEM

The short term market equilibrium solution is determined by the intersection of supply and demand. In the commercial fishing, the supply side is determined by the aggregate effect of independent actions by all fishermen, and the demand side is determined by the consumer preference and processor's decision behavior. In the recreational fishing the fishing opportunity determines the supply picture whereas the desire and willingness to pay for recreational fishing determine the demand function. In the following we shall discuss the commercial fishing sector in greater detail. Several simplifying assumptions are made so that the basic concepts, rather than the technical details, are emphasized. We assume that there is a single species aggregated into one cohort class. It is also assumed that all the fish landed are indistinguishable in quality and are supplied to the fresh and frozen markets without favoring one market over the other. This assumption can also be easily removed.

A.1 Fishing Fleet Tactics Submodel

The basic feature of this submodel is that it describes how different types of vessels compete in harvesting the same species. Commercial fishermen have to decide, sequentially, whether they want to continue fishing as long as a total catch quota has not been filled and the weather is good. Before developing a decision criterion for the commercial fishermen, let us first derive equations describing the relationship between fishing effort and landing.

Within a short period, the number of i^{th} vessels, V_i, can be assumed to be fixed, i = 1, -- n. Let us denote the initial time by t = 0. Assume that at t = 0, the catchable fish population (in weight) is denoted by N(0). Divide the short term interval into T intervals. Assume that all the vessels have been engaged in fishing up to time t, and within the interval $(t, t+\Delta t)$, the average effort/vessel is the same for all vessel types, i.e. $\Delta E_i(t) = \Delta t$ $i=1,...,n$. Let all the i^{th} type vessels have catchability coefficient

q_i = average percentage catch of existing fish population (within a specific area) per unit effort by the i^{th} tpye vessel

Then the amount of fish landed by the i^{th} type vessel within $(t, t+\Delta t)$ is

$$\Delta y_i(t) = q_i \, N(t) V_i \Delta t \qquad i=1,...,n \qquad (A.1)$$

where N(t) = fish population at time t. Assume the natural mortality of fish is M, then at $t + \Delta t$, the remaining fish population is

$$N(t+\Delta(t)) = N(t) - M\Delta t N(t) - \sum_{i=1}^{n} \Delta y_i(t)$$

$$= N(t) - N(t)\ (M + \sum_{i-1}^{n} q_i V_i)\Delta t \qquad (A.2)$$

which gives

$$N(t) = N(o)\ \exp\{-(M + \sum_{i=1}^{n} q_i V_i)t\}$$

If the average price per unit weight of fish caught by the i^{th} type vessels is p and the average variable cost per fishing day is w_i, then the marginal profit of the i^{th} type vessels for a marginal effort of Δt is

$$\Delta\Pi_i(t) \stackrel{\Delta}{=} p\ N(t)\ q_i V_i\ \Delta t - w_i V_i \Delta t \qquad (A.3)$$

Therefore it is profitable for the i^{th} vessels to spend additional effort in fishing if $\Delta\Pi_i(t) \geq 0$. If we assume that fishing effort is a sequential decision (i.e. at each instant of time t, the fishermen only decide whether they want to fish for an increment time $(t, t+\Delta t)$ but not for the whole future time path), then it is clear that the stopping criterion for the i^{th} type vessel would be $\Delta\Pi_i(t) = 0$, unless some hard constraints are binding: e.g. the total fish quota has been reached, or the fishing season is over.

The condition $\Delta\Pi(t) \geq 0$ can be expressed alternately as

$$p\ q_i N(t)\ V_i \Delta t \geq w_i V_i \Delta t \rightarrow \frac{p\, q_i}{w_i} \geq \frac{1}{N(t)} \qquad (A.4)$$

and if no constraints are binding, the i^{th} type vessels will stop fishing when $\Delta\Pi_i(t) = o$ or

$$\frac{p\, q_i}{w_i} = \frac{1}{N(t)} \tag{A.5}$$

Let us order the vessels such that

$$\frac{p\, q_1}{w_1} \geq \frac{p\, q_2}{w_2} \geq \cdots\cdots \geq \frac{p\, q_n}{w_n} \tag{A.6}$$

Then from (A.4) - (A.6), it is clear that the n^{th} type vessel will stop fishing first, then followed by the $(n-1)^{th}$ type and so on down to the first type. One can view the number $\frac{p\, q_i}{w_i}$ as a measure of economic efficiency of the i^{th} type vessels; it is related to price, catchability coefficient and operating cost of vessels.

Now let us consider a mathematical problem where we take p, w_i to be exogenous and maximize the total profit function by varying the time t

$$\Pi_i(t) = p\, y_i(t) - w_i V_i t = \int_0^t [p\, q_i V_i N(\tau) - w_i V_i] d\tau \tag{A.7}$$

then if t is not binding, the condition is when

$$\frac{p\, \partial y_i(t)}{\partial t} - w_i V_i = p_i q_i N(t) V_i - w_i V_i = 0 \tag{A.8}$$

which is the same condition as (A.5). This observation allows us to model the supply of fish by solving the following optimization problem:

$$\text{(OP)}: \max_{\{t_i\}} \sum_{i=1}^{n} \left\{ \int_0^{t_i} (p_i q_i N(\tau) V_i - w_i V_i) d\tau \right\} \tag{A.9}$$

subject to the constraints

$$\text{(a)} \quad N(\tau) = N(o) \exp\left\{ - (M\tau + \sum_{i=1}^{n} q_i V_i (\tau \Lambda t_i) \right\} ;$$

$$\tau \Lambda t_i \triangleq \min(\tau_i t_i) \tag{A.10}$$

$$\text{(b)} \quad \sum_{i=1}^{n} \int_0^{t_i} q_i N(\tau) V_i d\tau \leqq N^* \tag{A.11}$$

$$\text{(c)} \quad t_i \leqq t_i^* \tag{A.12}$$

Where N^* is the total quota, which in the absence of regulation would ghe fish population, t_i is the average length of fishing season for the i^{th} type boat within a certain fixed time period. In addition to the total quota, the model can allow for individual quotas, allocated according to boat types. More relevant perhaps a foreign boat quota may be represented as follows. If we let $i = 1$ then we have an additional constraint on foreign catch quota (N_f^*)

$$\text{(d)} \quad \int_0^{t_1} q_1 N(\tau) \, V_1 d\tau \leqq N_f^* \tag{A.13}$$

The total domestic landing Q is given by

$$Q = \sum_{i=2}^{n} \int_{0}^{t_i^0} q_i N(\tau)\, V_i \, d\tau \tag{A.14}$$

Where $\{t_1^0\}$ is the solution obtained by solving the OP problem.

Note that Q is an implicit function of many variables

$$Q = Q(p, w_i, q_i, V_i, T_i^*, N^*, N_f^*, i = 1, \ldots, n) \tag{A.15}$$

If we hold $\{w_i, q_i, V_i, t_i^*\}_{i=1}^{n}$ and N^*, N_f^* fixed, then Q is a function of the price vector p , and thus describes a short-term supply function. The model allows us to determine the impact of changing policy variables N_f^*, N^*, t_i^*, V_i and q_i on the supply of fish.

For computational purposes, we may want to partition the time interval into $\{t_i, t_2, \ldots, t_N\}$, $t_j - t_{j-1} = \Delta$, and approximate the integrals by summations:

$$(OP)': \max_{\substack{\Delta_i \leq \Delta \\ l_i = 1, \ldots N}} \sum_{i=1}^{n} \left\{ \sum_{j=0}^{l_i} \left[p\, q_i N(j\Delta) V_i - w_i V_i\right] \Delta + \left[p\, q_i N(l_i \Delta) V_i - w_i V_i\right] \Delta_i \right\} \tag{A.9$'$}$$

subject to the following constraints (a) - (d)

$$\text{(a)} \quad N(j\Delta) = N(o) \exp\left\{ - \left[M_j + \sum_{i=1}^{n} q_i V_i (l_i \wedge j) \right] \Delta \right\} \tag{A.10$'$}$$

$$\text{(b)} \quad \sum_{i=1}^{n} \left\{ \sum_{j=0}^{l_i} q_i N(j\Delta) V_i \Delta + q_i N(l_i \Delta) V_i \Delta_i \right\} \leq N^* \tag{A.11$'$}$$

(c) $l_i\Delta + \Delta_i \leq t_i^*$ (A.12)

(d) $\sum_{j=0}^{l_i} q_l N(j\Delta)V_l + q_l N(l_l\Delta)V_l \Delta_l = N_f^*$ (A.13)

where $l_i \wedge j = \min(l_i\ j)$. Let $\{\Delta_i^0, l_i^0, i=1,\ldots,n\}$ be the optimal solution of (OP)$'$, the total domestic landing Q is approximated by

$$Q = \sum_{i=2}^{n} \left\{ \sum_{j=0}^{l_i^0} q_i N(J\Delta)V_i\Delta + q_i N(l_i^0\Delta)V_i\Delta_i^0 \right\} \quad (A.14)$$

For the extension of the fishing fleet tactics submodel to a multispecies fishery, we define both directed and by catch catchability coefficients, q_{ijk}, for each vessel class. q_{ijk} denotes the average percentage catch by the i^{th} type vessel of existing fish population of the j^{th} species per unit effort when effort is directed at the k^{th} species.

A.2 Fish Demand Submodel

We aggregate the fish products into two types: fresh and frozen. Presently we are using standard econometric estimation techniques in simple log-linear equation form to determine the relationship between supply and demand (e.g., Boxdale [2]). More sophisticated versions of the price-quantity relationship may be substituted as developed.

$$Q_i^d = k_i (p_i^d)\alpha_i \qquad i=1,2 \tag{A.16}$$

Where Q_i^d is the quantity of form i demanded in the retail Market

p_i^d is the price of form i in the retail market

k_i is a constant

α_i is the demand elasticity (negative)

i=1 stands for fresh fish and i=2 stands for frozen fish

The domestic ex-vessel demand is obtained by the following simple relationship:

$$Q^e = Q_1^e + Q_2^e$$

$$Q_i^e = (Q_i^e - Q_i^f) \cdot C_i \quad ; \quad i=1,2 \text{ (material balance)} \tag{A.17}$$

$$p_i^d = C_i \cdot p_i^e + \beta_i \quad ; \quad i=1,2 \text{ (constant markup)} \tag{A.18}$$

Where Q^e = total ex-vessel demand

Q_i^e = Exvessel demand for form i

p_i^e = Exvessel price for form i

C_i = Processing loss factor for form i

Q_i^f = Foreign supply for form i

β_i = Retail markup for form i

The foreign supply is given by

$$Q_i^f = k_i^f (p_i)\alpha_i^f \quad ; \quad \alpha_i^f \text{ is the supply elasticity for imports of form } i\text{, and } \alpha_i^f > 0 \qquad (A.19)$$

In the demonstration phase, we impose $p_1^e = p_2^e = p^3$. With such an assumption it is easily seen that (A.16)-(A.20) give us unique functional relationship between exvessel price p^e and the total quantity demanded Q^e.

$$p^e = P_D(Q^e), \quad Q^e = Q_D(p^e) \qquad (A.20)$$

The simple log-linear demand equation expressed in (A.20) is easily extendable to a vector demand equation linking the various species through own and cross price elasticities. Parameterization however will occur as more data becomes available.

A.3 Market Clearing Mechanism for Commercial Fishing

The market equilibrium (p^*, Q^*) is determined by the intersection of supply function (A.15) and demand function (A.20), i.e.

$$Q(p^*, W_i, q_i, V_i, t_1^*, N^*, N_f^*, i=1,\ldots n) = Q_D(p^*) \qquad (A.21)$$

$$Q^* = Q_D(p^*) \qquad (A.22)$$

In this section, we describe an algorithm which computes the market equilibrium point.

Let us rewrite (A.9) as

$$\max_{Q,Q_1} \left\{ pQ + p_1Q_1 - TC(Q,Q_1) \,\middle|\, Q+Q_1 \le N^*, Q_1 \le N_f^* \right\} \qquad (A.23)$$

where

$$TC(Q,Q_1) = \min_{\Delta_i \le \Delta} \left\{ \sum_{i=1}^{n} w_i V_i (l_i \Delta + \Delta_i) \right\} \tag{A.24}$$

$$l_i = 1..N$$

subject to the constraints

$$\sum_{j=0}^{l_1} q_1 N(j\Delta) V_1 \Delta + q_1 N(l_1 \Delta) V_1 \Delta_1 = Q_1 \tag{A.25}$$

$$\sum_{i=2}^{n} \left\{ \sum_{j=0}^{l_1} q_i N(j\Delta) V_i \Delta + q_i N(l_i \Delta) V_i \Delta_i \right\} = Q \tag{A.26}$$

$$N(j\Delta) = N(o) \left\{ \exp\left[- M_j + \sum_{i=1}^{n} q_i V_i (l_i \Lambda j) \right] \Delta \right\} \tag{A.27}$$

$$l_i \Delta + \Delta_i \le t_i^* \tag{A.28}$$

We shall take p_1 to be exogenous and determine p, Q and Q_1 from (A.20) and (A.23).

Let us consider a purely mathematical programming problem

$$\max_{Q,Q_1} \int_0^Q P_D(\hat{Q}) d\hat{Q} + P_1 Q_1 - TC(Q,Q_1) \,|\, Q + Q_1 \le N^*, \; Q_1 \le N_f^* \tag{A.29}$$

If we assume that fish demand is such that $\frac{dQ}{dP} < 0$ and $\frac{d^2Q}{dP^2} < 0$, then it is easily shown that $\int_0^Q P_D(Q)dQ + p_1 Q_1$ is concave in (Q,Q_1) and $TC(Q,Q_1)$ is convex in (Q,Q_1). Therefore by the Frechel Duality Theorem [3] there exists (p^*, p_1^*) such that, if (Q^*, Q_1^*) is the solution (A.29), then it is also a solution of

$$\max_{Q,Q_1} \{ p^* Q + p_1^* Q_1 - TC(Q,Q_1) \,|\, Q + Q_1 \le N^*, \; Q_1 \le N_f^* \}$$

$$= p^* Q^* + p_1^* Q_1^* - TC(Q^*, Q_1^*) \tag{A.30}$$

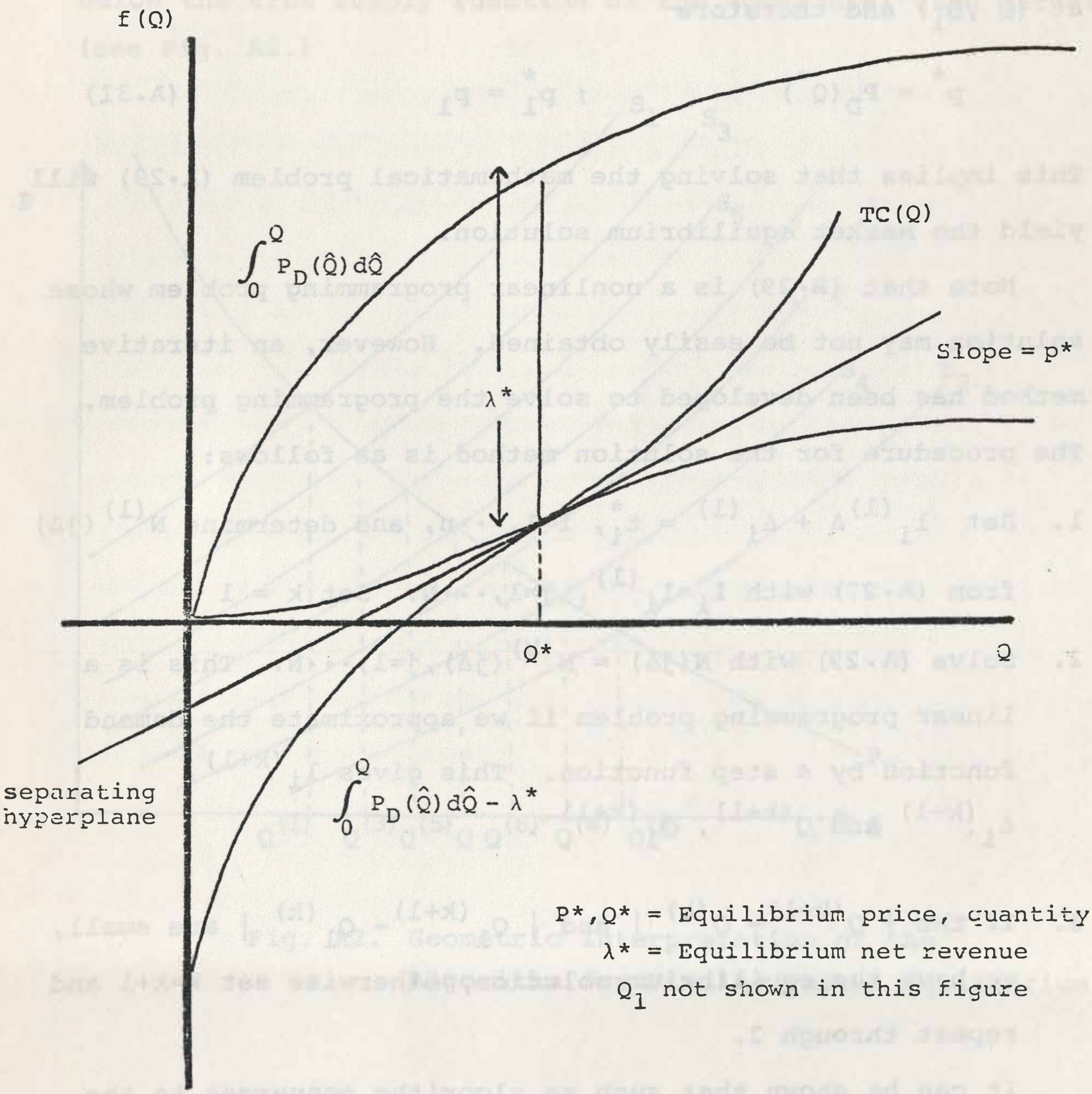


Figure A1. Geometric Interpretation of Frechel Duality Theorem

A geometrical explanation of such a result is given in fig. A1 Geometrically (p^*, p_1^*) is the slope of $\int_0^Q P_D(\hat{Q})\,d\hat{Q}$ and $p_1 Q_1$ at (Q^*, Q_1^*) and therefore

$$p^* = P_D(Q^*) \quad ; \quad p_1^* = p_1 \tag{A.31}$$

This implies that solving the mathematical problem (A·29) will yield the market equilibrium solution.

Note that (A·29) is a nonlinear programming problem whose solution may not be easily obtained. However, an iterative method has been developed to solve the programming problem. The procedure for the solution method is as follows:

1. Set $l_i^{(1)}\Delta + \Delta_i^{(1)} = t_i^*$, $i=1,\cdots n$, and determine $N^{(1)}(j\Delta)$ from (A·27) with $l_i = l_i^{(1)}$, $j=1,\cdots N$. Set $k = 1$
2. Solve (A·29) with $N(j\Delta) = N^{(k)}(j\Delta), j=1,\cdots N$. This is a linear programming problem if we approximate the demand function by a step function. This gives $l_i^{(k+1)}$, $\Delta_i^{(k+1)}$ and $Q^{(k+1)}$, $Q_1^{(k+1)}$.
3. If the $|\,Q^{(k+1)} - Q^{(k)}\,|$ and $|\,Q_1^{(k+1)} - Q_1^{(k)}\,|$ are small, we have the equilibrium solution, otherwise set $k=k+1$ and repeat through 2.

It can be shown that such an algorithm converges to the market equilibrium solution.[4] The proof of this can be described graphically by figure A1. At the k^{th} iteration, the linear programming solution is equivalent to finding the equilibrium market of a fictitious market whose demand function is the same as the true demand function but whose supply function is given by S_k which bounds either above or below the true supply function of the commercial fish market (see Fig. A2.)

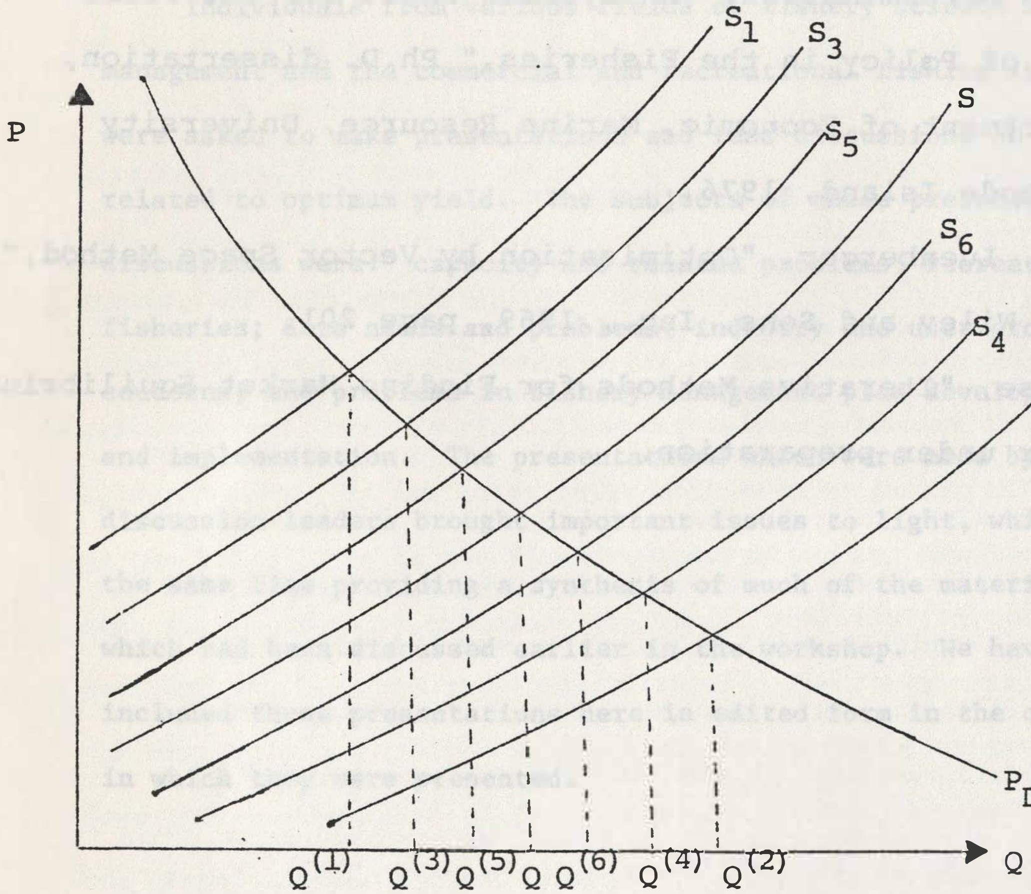


Fig. A2. Geometric Interpretation of the Algorithm for Finding Market Equilibrium

REFERENCES

[1] E. Tse is now preparing a paper on this topic.

[2] N. E. Bockstael, "Analysis of Investment Behavior and Price Determination: Analytical Input for the Formation of Policy in the Fisheries," Ph.D. dissertation, Department of Economic, Marine Resource, University of Rhode Island, 1976.

[3] D. G. Luenberger, "Optimization by Vector Space Method," John Wiley and Sons, Inc., 1969, page 201.

[4] E. Tse, "Iterative Methods for Finding Market Equilibrium," paper under preparation.

IV The Council Session Discussions

Individuals from various fields of fishery science and management and the commercial and recreational fishing industry were asked to make presentations and lead discussions on topics related to optimum yield. The subjects of these presentations and discussions were: capacity and related problems; recreational fisheries; data needs and problems; industry and user group concerns; and problems in fishery management plan development and implementation. The presentations which were made by these discussion leaders brought important issues to light, while at the same time providing a synthesis of much of the material which had been discussed earlier in the workshop. We have included these presentations here in edited form in the order in which they were presented.

Capacity and Related Problems

Chairman, James A. Crutchfield:

Professor, Department of Economics

University of Washington

Member, Pacific Fishery Management Council

I would like to review briefly three sets of things from the standpoint of a Council member faced with the task of interpretation and getting regulations out.

First, some comments on the technical discussion of our capacity to define the elements of optimum yield, and more specifically to measure with acceptable degrees of accuracy the elements of optimum yield. I would stress <u>with acceptable levels of accuracy.</u> Secondly, I would like to add my own comments about the practical problems in the selection and weighting of the elements of optimum yield specified in the Act that apply to a specific management plan we have to put in place, and some comments about what we mean by a reasoned interpretation of the best available data and the exercise of the Council's judgment. Finally, I would like to talk briefly about the question of capacity and its measurement, which enters into the matter of optimum yield very directly, as anybody who has tried to manage a fishery will testify to very quickly, and secondly as a technical problem we have to solve in meeting our responsibilities in defining quotas available for foreign fishermen.

We were asked by the legislation to evaluate and weigh a number of objectives for which there is no single common denominator. Nothing we say is going to change that fact. The issue is whether we can provide measurements which spell out very clearly the alternatives that face us and the costs of choosing one alternative over another to the satisfaction of our constituency, the general public, and more specifically, the Courts.

I would like to make one other point before I launch into this quick review. Optimum yield, however defined, however interpreted by any Council, is not a device to make as many people as happy as possible. This is the Fishery Conservation and Management Act that we are asked to implement as Council members. In a way we have had the fun, the easy part of kicking the foreigners out to the best of our ability. We now face the necessity of getting down to the management of the fishery as a whole, including our own competing user groups. And that's when the choices are going to start binding.

I would add that I don't think it is necessarily true that the failure by the Councils to write and implement tough scientifically and socially justifiable regulations will get us into any more trouble with the Courts than a loosely written attempt to go in seven directions at the same time. I don't think optimum yield should be interpreted to mean that.

On the technical side, as a social scientist I was very much impressed with some excellent papers -- which I hope all of you will have a chance to read -- stressing the fact that the term "maximum sustained yield" in the legislation will have to be bent very substantially if it is to mean anything sensible. What we really want, I am sure, is a measure year-to-year, season-to-season, of the biological availability of animals to be harvested. Since MSY, if it means anything at all, is a kind of bastardized average of long-term numbers, it bears very little resemblance to what is appropriate to be allocated to the competing users in any given year.

To the extent that we have, and/or can develop the capacity to monitor the underlying parameters that determine the availability of fish for a year in which the plan is to function, we can do better year by year in many, if not most, fisheries, than just adhering to an average with wide variations around that average. As several of the papers pointed out, adhering to a simpleminded concept of an average sustained yield can result in very serious losses, both economic and biological. I think that was very important and well brought out in the papers.

The economic factors: We unquestionably have to deal not only with the benefits, economic benefits, to society of the alternative measures that we consider, but with the distribution of the costs and benefits that result. That's not an impossible task by any means. But, it is a most difficult task. It was stressed hardest by Dr. Anderson, and I will repeat it here for the benefit of all, that while economists, as such, and others have nothing particularly useful to say as to how benefits and cost of the fishery management should be distributed among user groups, we do have the responsibility and capability of identifying the winners and losers and of indicating, if you want to make sure there are no losers at all -- spreading opportunity among as many people as possible for example, in an overcapitalized fishery -- how much it's going to cost you to do that. These tradeoffs can be quantified and the decisions of Councils, I think, made considerably easier as a result.

The determination of efficient harvesting and its relation to management alternatives, we didn't say much about it. It cannot be divorced from the problem of excessive amounts of gear and harvesting capacity in many of our fisheries. We need to spell out the kind of economic gains that can be realized by more rational harvesting of many of our more valuable species than we are undertaking at the present time, and point out also that in a meeting, hopefully to take place in the not too distant future, some ways of approaching that difficult problem with the least possible pain will be explored in some detail. But, it's awfully hard to define what you mean by the optimum yield if you are so severely constrained by excessive harvesting capacity that you have no leeway with regard to choice of management alternatives in the direction of efficiency.

The role of recreational fishing, which is very important to most of the Councils, if not all of them, was discussed, I am afraid, not as satisfactorily. I think our conclusions could be summarized quickly this way: The recreational fishery provides a different product than the commercial fishery. It's the fishing experience, one component of which is success ratios in fishing, but only one of the components. As a result, the optimal population, its size and age distribution, from the standpoint of a recreational fishery typically will be significantly different than the optimal population and age distribution if you are seeking to maximize either physical output or economic benefits from a purely commercial utilization. And that presents some really rough measurement problems.

We do not normally have a market price for access to a recreational fishery that compares to the market prices for commercially sold products. Our attempts to simulate those market prices, what people would have been willing to pay for what is obviously a highly valued service, are still at very early stages. The numbers aren't very good.

That does not mean that we should not continue with efforts to improve those analyses and to sharpen the numbers that we have. But, at the moment, we are severely constrained.

What this means in practice, I suspect, is that recreational fishing is consistently underweighted in our concepts of optimum yield, and is likely to get less attention than it probably should have from the standpoint of the long-run well-being of the fishery as a whole, and the user groups as a whole. There is a measurement problem here of major proportions that will fall on the judgments of the Councils, since the numbers are significantly less reliable and less available.

I would like to point out something that Hal Lyman noted repeatedly: We don't make very good use of the numbers we have. And that is a responsibility we will have in the future.

There was much discussion of our need for better understanding of the sociological factors involved in those who fish and those who use the products. I think there was some consensus that work definitely should go on but that it will take time and is probably part of our longer range planning, rather than the short term fire brigade work that we still will be faced with in the near future.

Finally, with respect to capacity problem -- it sounds so simple, and it turns out to be so dirty in practice. It's quite clear to anyone who has tried to deal with the problem already that the Act could not be interpreted to mean simply physical capacity of the American fleet, or in some cases where the constraint may not be in harvesting but in processing capability. What is needed is an economic measure of what the American industry can and will take in a given management period with which we are concerned, given our best estimates of the availability of the fish involved and our best estimates of the prices that will prevail. That is basically our short-run problem. It is a problem complicated in almost every Council region, I am sure, by the fact that we have multi species fisheries, typically, and the targets can be altered, within limits. We have many types of boats and gear that can be shifted in season, as well as between seasons, to fish in different areas for different species. And the measurement of capacity has got to involve some kind of analysis of how the fleets respond using that mobility, in response to price and physical availability as incentives for making money.

These are not easy numbers to come by at all. All of you I am sure are aware, the Councils, if they face any single threat to their credibility and their success as an exciting new approach to fishery management, face one in the danger of arbitrary assessment of American harvesting capacity, which are nothing more than wish lists, which are not met in practice and which lay us open to the charge that we are not in fact managing fishery according to the guidelines laid down in the legislation.

The determination realistically, then, of what the American industry is capable of harvesting is basically an economic analysis of the supply function of quantities that will be taken, given our production and price estimates. And the Councils must be prepared to develop those kinds of estimates to test the reaction of industry and its input as to what it feels it can harvest.

The possibility of disagreement, and the need to resolve those disagreements between industry and Council, is very clear. We both need the best information that we can get.

One final point, I think it was encouraging throughout the discussion to note the general recognition and acceptance of the fact that the best technical information is not intended to, and cannot replace the informed judgment of the Councils themselves when decisions are to be made. With the best intentions, and more money than we will ever get, all of our major decisions will be made on the basis of incomplete and not very timely data. Judgment will be the essence of the way we interpret them.

As far as the weights of the different elements in optimum yield are concerned, I might clarify perhaps what others have said, what I feel strongly myself, but what I think is a perfectly appropriate illustration. There are principles widely accepted and successfully practiced for the valuation of, for example, urban real estate. The principles applied in different places to different parcels of land obviously produce significantly different values per square foot. This does not mean inconsistency, but consistency.

I think what we are looking for is the same approach within the Councils: not that they come up with the same relative importance to be attached to recreational fisheries, not that they come up with the same importance to be attached to chronic unemployment in isolated fishing communities -- which may be very important in some areas, and not in other areas -- but, rather, that they recognize and evaluate these modifications, with what biological capabilities we have, in a reasoned and justified fashion. I don't think the Courts will ask any more of us -- not that we be right, but that we be reasoned in what we do, and make the best use of the available data that we can generate, or find elsewhere.

As far as the work modeling is concerned, everybody flinches when it is mentioned. But, if you have been here, I think you would have been favorably impressed by the fact that the term has been used repeatedly here as a way of organizing very complex situations and finding out how little we really need to get in the way of data to make the decisions we have to make.

Interpreted in that fashion, I don't think there is any real conflict between modeling and informed common sense, which is what the Councils really deal with.

Recreational Aspects Of Optimum Yield

Chairman, Richard H. Stroud

Executive Vice President, Sport Fishing Institute

Member, Scientific and Statistical Committee

South Atlantic Fishery Management Council

As early as 1950, many inland fisheries managers were stressing the social and economic aspects of recreational fishing on a basis of parity with biological factors as the consciously-stated objectives of fish management--in effect, optimum yield (OY). It was largely in the ocean fisheries, where principal concern at mid-century was to maximize catches (hopefully, thereby, profitability) in commercial fishing enterprises, that the principle of maximum sustained yield (MSY) was nourished to the exclusion of most other considerations. A corrolary concept was that of "full utilization," conceived in narrow terms of use of fish exclusively as human food, directly or indirectly, with all other possible uses (i.e., ecological, recreational, scientific, esthetic) ignored or fatuously denigrated.

In most fresh waters of the United States, until recently except the Great Lakes, the chief goal of aquatic production has, for many decades, been primarily to serve recreational fisheries needs. Tolerance or encouragement of commercial fishing has prevailed largely in those circumstances where it was perceived to benefit or at least not harm or conflict with the recreational fisheries.

In the late 1950's, economists joined these early inland protagonists of OY and began to take open issue with the concept of MSY in the marine commercial fisheries. They argued for an economic equivalent that would generate the greatest profitability rather than the greatest catch, recognizing that the latter often led to economic adversity. The 1958 United Nations Oceans Convention (Geneva) reflected the increasing influence of economists by incorporating the term "optimum yield" in the convention text as the appropriate management objective for the marine fisheries--implicitly, the commercial fisheries. The "bottom line" continued, however, to call for production from marine fish stocks of "a maximum supply of food."

Recreational fisheries leaders have for several decades been active in promoting the concept of optimum yield, in generalized terms. Their successful efforts climaxed in the organization, under joint auspices of the American Fisheries Society, the National Oceanic and Atmospheric Administration (U.S. Department of Commerce), and the Sport Fishing Institute of the hallmark Symposium On Optimum Sustainable Yield As A Concept In Fisheries Management, held at Honolulu, Hawaii, September 9, 1974.

Public Law 94-265 (the Fishery Conservation and Management Act of 1976) generally follows the thrust of the 1974 OSY Symposium in defining optimum yield, noted in the Draft Report of the Technical Sessions (of the current Workshop), to be the yield which:

(a) will provide the greatest overall benefit to the nation, with particular reference to food production and recreational opportunities; and

(b) is presented on the basis of MSY from such fishery as modified by any relevant economic, social, or ecological factors.

With respect to the related deliberations during the first two days of this particular Workshop, the Draft Report of the Technical Sessions has this to say concerning Recreational Fishing: "The recreational fisherman is one of the winners or losers in optimum yield determinations. The recreational segment is the sleeping giant in our understanding U.S. fishery management, and we must know a great deal more about it before we have a complete understanding of the total fishery management process. The principal problem associated with the recreational fishery is to to evaluate an activity which uses a resource, but which has objectives other than the direct consumption of the resource. Much work is needed on the theory and analysis of recreational fishing: the measurement of demand, the perceptions of the quality of the recreational experience, and many other aspects. Another of the many statistical requirements is a measure of the socio-economis characteristics of the recreational fisherman."

In the recreational fisheries it is necessary, for achievement of fishing satisfaction, to accommodate the important but elusive element of "quality." Difficult to quantify at best, the "quality" factor obviously requires accommodation of a variety of angling experiences. The species sought, caught, and/or harvested, the balance between sizes and numbers of fishes available for capture and harvested, the situations in which they are caught, even the methods employed, are among the important considerations.

Marine fisheries theorists, however, ought not to make the serious mistake of assuming that the sole object of recreational fishing, as apparently implied in the Draft Report of the Workshop Technical Sessions, is to have an outdoor poetical experience on the bounding main, to feel the salt spray in one's face, a heaving deck under one's feet, a mere tug on one's line....Inextricably involved, as well, is the personal harvest of suitable finfish and shellfish from the sea to take home for fresh and wholesome eating, to share with friends and neighbors....The two aspects have long been indivisible for the vast majority of anglers.

It may well be probable that OY is not a precisely quantifiable number in our present stage of scientific ignorance about marine angling parameters. I suspect that it will long defy such packaging; rather, it is a concept with widely variable connotations.

What about the social factors? We know only crudely,indeed, how many people engage in recreational fishing, to what extent (frequency they fish, why they fish, what they seek out fishing, how many of what species and sizes of fish they actually catch, how often and at what rate they catch fish of various species, where and when they do it, etc.

What are acceptable marine angling catches in terms of species, sizes, numbers? In this connection, can we learn anything useful from the several decades of preceding parallel experiences in managing the inland fisheries?

At Auburn University (Alabama), in the 1940's, a pioneering effort was made by Dr. Homer Swingle and his associates to develop information of this character for inland pond fishing in the mid-South region. Their innovative efforts led to the propounding of a series of arithmetic ratios among various components of many experimental fish populations by which fish managers might judge pond "balance." The latter was defined in terms of various criteria contributing to a satisfactory state of fishing, at least a function of:

(1) minimum sizes of various species of fish that would be retained as acceptable sizes by anglers, rather than being voluntarily rejected; and

(2) the frequency of catching those acceptably-sized fish.

Thus, for example, quarter-pound bluegills harvested at the rate of one per hour produced acceptable "quality" of fishing. Here, then, was one of the early attempts to quantify some of the social perceptions of angling that were necessary for fish managers to accommodate. Given this criterion, biological management could be devised so as to satisfy this perceived social objective in angling.

What about the economic factors? What are anglers willing to pay for their fishing? How do they value their opportunity to harvest fish on a personal basis? A number of methods are in use to approximate such valuation, none totally satisfactory or practicable. These include:

gross expenditures

travel costs

indemnification for deprivation of opportunity

rental costs

What new approaches, or useful refinements to the foregoing can be developed? It's an area of urgent need, but of poor attention.

What about the ecological factors, thus far a rather neglected topic of discussion in this Workshop and its related Draft Report of the Technical Sessions? Recreational fishermen have a huge stake in the vast supplies of many species--ex., anchovies, menhaden, squid, etc.--that provide food for the larger carnivorous (predator) species that anglers often seek. They and other conservationists have corresponding concerns that other life forms--seabirds, marine mammals--be allocated substantial shares of prey fishes to sustain them in appropriate abundance. They are equally concerned that adequate safety margins be reflected in OY determinations in order that likely errors in estimations of stock abundance will be sufficiently accommodated to forestall biological disasters, otherwise, from possible overfishing.

Contrary to the traditional "full utilization" perceptions, prey species are not necessarily "wasted" if not caught in the commercial fisheries for reduction purposes.

It must be remembered, finally, as one Councilman asked me to remind the Workshop participants, that we are herein concerned with implementation of the Fishery Conservation and Management Act. One inference could be that Conservation of fish stocks should be assured first--and their utilization only secondarily.

Going back to the definition of Optimum Yield, as stated, it should be borne uppermost in mind, that:

(a) the two major national benefits specified may be inferred to be coequal benefits before the law, viz:

(1) "food production," and

(2) "recreational opportunities."

Thus, the marine recreational fisheries may not, as stated in the Draft Report of the Workshop Technical Sessions, be either "winner" or "loser." It should also be recalled that, according to P.O. 94-265, optimum yield is to be determined:

(b) on the basis of MSY, as "modified" by another set of factors, as relevant, that may also be inferred to have equal weighting in the law, viz:

(1) economic--a consideration that is specifically enjoined in Sec. 301(a)(5) from being the sole determinant of conservation and management with respect to utilization of the fisheries resources

(2) social

(3) ecological--a consideration that is highlighted in Sec. 304(e) through mandated "biological research concerning the interdependence of fisheries or stocks of fish." Obviously, Congress intended this factor to weigh importantly in the planning process.

I hope and trust that these few introductory remarks have provided a useful basis and springboard for comprehensive discussions to be pursued during the currently-allotted hour of the Workshop relevant to recreational fisheries implications of optimum yield....

During the first day of the Council Session of the workshop, Hal Lyman chaired a panel whose speakers addressed many of the concerns of those outside of the traditional governmental and scientific fisheries institutions, specifically in the industry and the consumer. The speakers were Bill Mustard, Lee Weddig, Harold Lokken, and Chris Weld. Their comments presented some new and interesting points of view, and we have included them in this part of the report.

Harold Lokken

Chairman, North Pacific Management Council

I would like to share with you a number of thoughts that I think may be appropriate to the occasion, particularly from the standpoint of the boat owner and the fisherman, the people with whom I have been directly associated for many years.

On the subject of discussion today I am somewhat ambivalent, as I have different views on the term OSY. The first is one of cynicism, for I believe it's impossible for anyone to define the term with a degree of accuracy that is required if the definition is to be usable in reshaping the views of those affected adversely by it. It is one thing to devise Act definitions. But, it is another thing to impose a definition on those who would be affected by it.

From the standpoint of this cynicism, I rationalize my presence here by the thought that I wanted to see what the hell is going to happen next. I might use the philosophy of the old time academic economist, who was taking a course in economics at another institution for the primary purpose of finding out what the hell the new economists were talking about.

The second view I hold is that the problem is of too serious a nature to be dealt with lightly, or facetiously. It merits both time and effort to see if it cannot be defined with a sufficient degree of preciseness to at least be a guide for use by those who have the responsibility to manage our marine resources for the benefit of not only those that are interested in them today, but also those that will be interested in them in the future.

I don't know which of these two opposing views will turn out to be the more accurate. But, I do believe we have an obligation to test the second one before we give up. Cynicism might be all right for some, but it has never built anything, and it is a destructive force rather than a constructive one.

By the same token, I don't thing the search for a precise definition of optimum yield should be a lifetime pursuit, nor should it be justification for what some call professional welfare. By that I mean the employment of the time of professionals, or the expenditures of professional funds beyond a reasonable period and amount. There are more practical uses for these talents and funds that have a greater level of urgency in the next five and ten years. I am referring to the task of converting the harvest of our marine resource from an uncontrolled system to one of limited restraint. This task in my opinion will require the employment of the best of our talent and facilities. The definition of optimum yield will play an important part, but a lesser role, in this task.

The definition of optimum yield requires an awareness of the practical. Let's assume that a species of fish exists in three management jurisdictions. Some of you in this room, I am quite sure, know what I am talking about. The fish are juveniles in the first jurisdiction, halfway between juvenile and mature in the next, and mature in the final jurisdiction.

The purist looking at the problem would say that species should be taken in the third, or last, jurisdiction only so as to maximize the poundage of species, taking into consideration, of course, the need of reproduction to allow for future generations. This would take care of the biological considerations, and, generally, economic considerations to a large degree.

But, it would not satisfy social or political needs. Those who were able to harvest the species in the first and second jurisdictions might not be able to operate in the third jurisdiction.

The political and social imbalance here requires careful adjustment, and, perhaps, demands suspension of the general rule to fit the requirement of reasonableness. The amount of adjustment involved, of course, will depend largely on the amount of political and social pressure that is applied for the change in the general rule. The problem is to define optimum yield so as to permit necessary adjustments without making the definition so general and so loose that it ceases to have any beneficial meaning.

Perhaps it would be desirable to have several definitions, each to fit a different situation. Species that conform to a common pattern could be treated as one. Groupings could be , to name a few, highly migratory species, anadromous species found in two or more jurisdictions, anadromous species found in only one jurisdiction, species primarily used for recreation, species primarily taken commercially, sedentary species, and so on.

The danger here, of course, is the opportunity it gives to anyone who would want to pervert the system by contending that the definition for one species, or a group of species, should be applied to another species, or a group of species, where there was no degree of commonality among them.

Another important factor to watch in devising a definition is to take into consideration not only the effect of the application of the concept of optimum yield upon a single species, but also the effect of the concept upon other species that are combined into an ecosystem. It would be a backward step if we would maximize the yield from one species only at the expense of another. It might be that one species is expendible. But, before you allow this to occur, managment should take all factors into consideration.

The practical definition of optimum yield must recognize also that our living resources are not static. They are in a state of constant change. One exists today, but may not exist tomorrow.

Species may be abundant one year and scarce the next. Our definition must allow for these changes. There must be enough flexibility to adjust for them.

In this context, one word of caution is indicated. The definition must be sufficiently rigid to allow for planning at least a year or a season in advance. It must not be used as an excuse for overnight changes as advocated by pressure groups when short-term conditions seem to favor change. The definition should be such as to require fairly long-term planning in advance and not allow management by day-to-day decisions. This requires a great deal of fortitude without which the philosphy of optimum yield will be solely a political concept of no great value. Advance planning of reasonable length will also impress a degree of discipline upon our managers and planners that in my opinion will improve the long-term acceptance of the management regime.

Dollars and cents should not be allowed to predominate in our search for a definition. Rather, the need of our resources should be of the first priority. It is much easier to adjust dollars and cents than it is to adjust resources. If we keep our resources in top conditions to the greatest extent possible, the dollars and cents will be maximized over the long run.

We must at all cost make sure that any deviation from maximum sustainable yield to optimum yield, for purposes other than biological, be of a temporary nature, or the deviations will threaten the basic health of the resource.

Another approach to the development of optimum yield could be to work from the bottom up rather than from the top down. Instead of trying to establish rules first and then apply them, might it also be possible to start with no rules and allow the rules to be developed segment by segment by testing them in what I call the front line trenches? This is where the managers and managees meet, sometimes in combat. What comes out of this confrontation generally sets the terms of management. Subsequently, it results in rules that are practical and acceptable, up to a point, to those to whom they apply.

It probably should be said also that if the rules are developed from the top, the testing will still be done at the bottom. Under many circumstances, the top rules will be completely ignored.

One of the most difficult parts of a successful definition of optimum yield is that concerning allocation. In this context, one must consider existing laws which allocate resources among different user groups without great regard for optimum yield. Some examples of this are Indians and non-Indians, different types of gear, sports versus commercial, tuna versus porpoises, aesthetic versus utility, environmental as opposed to food production, and many others. It is to be hoped that the concept of optimum yield could be so defined that legislation in the future will take into consideration the principles which can be agreed upon today, and that also the statutes that are on the books today can be interpreted so as to embrace these concepts in the future.

Another difficulty in our quest for agreement on optimum yield concerns the problem of accepting objectives which are probably non-enforceable, as opposed to one which is in the realm of possibility. The first sets up a principle which may raise perception to a higher level. The other is achievable, but at a lower level. Both concepts have advantages.

In my view, at the present, I tend toward the latter. In our search for agreement on what optimum yield means, we should not expect to solve all of our problems. We are still dealing with dynamic conditions. And we are dealing with human beings. Once a consensus is reached, we must still make sure that our original definition of optimum yield is still valid under new conditions which are bound to appear.

I presume I have raised more questions than I have answered at this stage in our search for agreement on optimum yield. I believe this to be appropriate. In other words, one should not give a verdict before all the evidence is in. This workshop is one place where some of the evidence is being presented. And I hope before too long that I will be able to have my own views to be presented in a more positive fashion on the subject, rather than to talk about questions and generalities.

Many individuals in all levels of industry, education, and government will participate in what I choose to call the pursuit of an agreement on an intellectual objective. I only hope that what we eventually come up with is equally understandable by the square heads, as well as the egg heads.

William S. Mustard

President, Marine Resource Associates

I was asked to speak briefly on the commercial fisherman's attitudes or opinions of OSY. I was also asked to relate that from the standpoint of the national fishing industry.

There doesn't seem to be a national fishing industry. In the Eastland Survey, we counted well over 300 segments to the commercial fishing industry alone. Most of these 300 segments have their own organizations. These organizations are affiliated in many different ways.

However, all of these various groups around the country, who operate in many cases completely different from one another on completely different species, were in some form or another rather active in the development of extended jurisdiction. What I would like to do is to briefly run through the development of the several house bills. I won't get into the Senate bills. I will just deal with the sections that relate to Council's responsibility and to the definition of OSY.

The concept of extended jurisdiction started with Don Clausen in California back in 1966. That bill was introduced in various forms year after year until the impetus grew in 1974. At that time Mrs. Sullivan and Mr. Dingle introduced HR-15619, that was the Fishery Conservation Act of 1974, one of several for the next couple of years.

The original concept for this early legislation was that the Secretary shall promulgate regulations governing fishing in the fishery zones, for both international activities and all domestic activities.

The early thrusts of the legislation which started to catch hold in the Congress gave all of the regulatory authority to the Secretary of Commerce. The early definitions for the purposes of extended jurisdiction were conserving and managing the fish in such waters and in such manner as the Secretary shall determine will result in the optimum overall biological, economic and social benefit. That was one of the early legislative definitions, or attempts to crank in optimum yield.

But, there was little or no comment as to who was going to do this, how it was going to be developed, or what process it was going to take.

In the early legislation there was some reference to an advisory committee. Then, it grew to three advisory committees -- one for each coast. Each advisory Council would have nine menbers, six of whom were from the industry. That would give basically eighteen people across the United States -- six from each region -- a chance to advise the Secretary on fishery management.

That, and several other bills of that type, did not make it that year. However, it generated a large deal of interest in the problems of fishery management, and the original 200-mile limit legislation, which was actively supported both commercially and recreationally, grew page after page by the weeks into several bills.

The following year some of the more popular pieces of legislation were HR-3412, HR-1070, HR-4582, and HR-200.

The legislation that year, and there several other bills -- these were some of the main ones -- hit upon several concepts which were modified extensively the following year. Some of these earlier concepts were introduced early in 1975. The policy as established by one piece of legislation was to establish a management process intended to achieve and maintain the optimum yield from fishery resources under circumstances which enabled the States, the fishing industry, the consumer, and environmental organizations, and other interested persons to participate or advise on the establishment of management plans and regulations.

There were several groups that were lobbying in Washington for some form of fishery management extended jurisdiction who were seriously concerned about their lack of access into the management process. There was only one bill that early session that even mentioned the fact that these other groups could possibly gain more than just an advisory role.

As some of this legislation developed, one bill referred to the term optimum yield meaning a yield which provided the greatest benefit to the nation as determined on the basis of all relevant economic, social, biological, ecological, and environmental factors. In the beginning, that was felt to connotate more of the economic regulation.

Another piece of legislation that same year defined optimum sustained yield as the largest economic return consistent with the biological capabilities of the stock.

Then, there was one bill, which Harold Lokken is quite familiar with, that established a national board which had some powers and advisory capability. Another piece of legislation that same year recommended that the Secretary consult with other federal agencies, state agencies, appropriate advisory councils established under Section 6, the commercial and recreational fishery industries, and to the extent practicable, any other persons having an interest in the conservation of fisheries involved in the marine fishery resource.

As this legislation progressed in 1975, the idea of a semi-public/private type of corporation, or board, or council, started to gain a great deal more acceptance. In one piece of legislation it stated that a national board shall be composed of fifteen members who have been appointed by the Secretary. At least one member shall represent, or have a background, in a commercial fishery, recreational fishery, processing, consumer organizations, and environmental organizations, and academic organizations.

However, some of the other legislation floating around made the eligibility requirements for membership in those various boards, or councils, very restrictive. Again, in one of these pieces of legislation, they set out some responsibilities. There were no comparable provisions in any other legislation of that time. It said it would be the responsibility of the national board to advise the administrator with respect to fishery management issues and approval of fishery management plans. But, at this point in time, outside input into the management process was very limited and of an advisory nature only.

Later, three bills developed regional fishery management councils. And there were just about every different combination of management council organizations that you could think of. These various types of advisory councils, again, were limited in scope. The membership was limited to much smaller numbers of people than now exist. The councils had much limited powers compared to the Councils now. In fact, one of the pieces of legislation said that four members at large in one of these councils shall be qualified individuals recommended by the national governors' conference, one of whom should be a representative of a coastal state. On that rather interesting standpoint, the individual on one of those advisory bodies must be someone who is distinguished for his knowledge and experience in fishery management and conservation, and who is equipped by experience, known talents, and interests to further the policy of this Act.

I don't think many of the present management council members could qualify on some of that criteria.

It seemed at that time that the biological managers of the fisheries still thought that fisheries could be managed by strictly a large group of biologists. The economic, the social factors, and several others were discussed. The language was in various pieces of legislation. But, it wasn't until the following year that the commercial and recreational interest in the environmental and consumer groups really got to work on this bill to insure the additional outside input which we are now charged with providing.

The process to get that outside input even went as far as developing extensive Congressional review of the management plans. Perhaps it was felt that if the agency really bombed on a plan and didn't listen to its advisory council, then, the Congress would take a crack at changing it because of opposition, and so forth, from the constituency.

I won't go into the makeup of some of the earlier boards. But, basically, throughout that year, again, they were all for advisory in nature. As we got on to the development of Public Law 94-265, HR-200 -- for which Don Claussen graciously gave the numbers to Gary Studds because it had a ring to it -- they very clearly identified what all the various groups who were lobbying on the legislation and the Congress intended to mean by some of the terms and phrases. The term optimum yield was reasonably well-defined, but purposefully left vague. Now, if that sounds like an inconsistency it is because the Councils themselves which were now given much greater management authority, were now optimum yield management councils. They were a broad mix of constituency groups. user groups, government agencies, state agencies. It was felt that this mix of people could do a much more significant job in managing the fishery than some of the previous pieces of legislation.

The national standards for fishery conservation and management, in Section 201, was basically intended to be the primary responsibility of the Secretary to see that the plans that were generated by these Councils, and the initial round of preliminary plans -- the major responsibility, as many of us who were lobbying on this legislation felt the Secretary's role should be -- would be basically an oversight of a plan that was established within the Councils by the extensive use of advisory committees made up of industry participants. Again, this legislation, in Section 302, organized the Councils that we have now. The list of qualified individuals was substantially modified to again allow for broader public participation.

The whole legislative history of the development of this management process stresses the involvement and active management of people from the industry on the management councils. By "the industry," I mean commercial, recreational, and the other environmental segments. It says clearly that the function of each Council will be to prepare and submit to the Secretary a fishery management plan. It says that the Councils will assess and specify the present and probable future conditions and the maximum sustainable yield and optimum yield from the fishery, including a summary of the information utilized in making such specifications.

It also says that the portion of such optimum yield which on an annual basis will not be harvested by fishing vessels of the United States can be made available to foreign fishing. It's rather clear that the intent of the industry's involvement with this legislative process, and the Congress in passing this Act, was to give the Councils the first-run management arm, or capability.

The speakers that we listened to earlier, who are now conspicously present in most cases, were telling you members of Councils how they were going to manage the fisheries, or give you the data you need to manage your fisheries. The intent was for you to find out more about the fisheries in your area, even if you are already involved in them, and for you to come up with many of the facts and figures and justifications for the decisions you have to make. You have to acquire data from wherever you can attain it. You are not limited to any one source. The data should be legitimate. It should be justifiable. And even with the best data available, you all now know that it would be conspicously weak. In order to get creditability as a management agency, which you now are, you have to use extensively the advisory committee process. You have to become much more involved in various segments in the industry in your geographical range. You may think you were knowledgeable about the particular segment of the industry in your area. I have been involved in many various segments of the industry around the country, and you never know enough about this industry to make your decisions completely accurate, or one hundred percent. You just can't reach that level of accuracy. You are going to make a lot of mistakes. A lot of people are probably going to get mad at you.

The way to avoid that is to involve as many of them as possible in the management process through the advisory committee system. In fact, one section of the Act, in Section 304, the Secretary may not include any fishery management plan, or any amendment to any such plan, presented by him, a provision establishing a limited access system, unless such a system is first approved by the majority of voting members of each appropriate Council.

Here is a case where the Congress has given the Councils a veto over plans that could have been promulgated by the Secretary. You, the Councils, are definitely the management agency.

Again, in the summary, or the foreword to the committee report, which tries to explain some of the language in the Act, it says that each Council is directed to prepare a management plan for each fishery within its geographical authority. Again, they stress that each fishery management plan shall specify the present and probable future condition of the stocks and the maximum sustainable yield and optimum yield from the fishery involved. It shall assess and specify the capacity and the extent to which the U.S. fishing vessels shall harvest such optimum yield, and the portion of optimum yield which is not so harvested will be made available to foreign fishing.

The only way we can find out that information is to go out and get it from the industry that is involved in that fishery and check and see what other industries are planning to do with that fishery, or that resource. The expansion plans that are taking place in most of the fisheries I've looked at around the country are substantial. Many new boats are being built.

Many species are going to be more extensively harvested than in the past. The marketing system is starting to grow rather significantly. In the last couple of years I have seen many new people that came into the fishing industry from other industries that are now involved in marketing and distribution companies. They are looking at export potentials. Since 1973, with the way fish prices have been rising on the international markets, any fishing company could, or series of joint venture companies could, very effectively compete in the international markets. The days when the small domestic producer or small fish house simply could not compete technically don't exist with the new talent that is coming into the industry, with the information that is available to them. They can very effectively compete both on the domestic and international markets.

As Lee Weddig said, in the industry we are fishing for money, not just fish. In many cases we will switch gear and equipment to hit a species where the market is a little stronger. There is a great deal of flexibility which exists in some areas, or in the jurisdiction of some Councils. So, the plans will have to be flexible. They will have to be developed with a great deal of input and communication.

Your main problem is going to be getting the creditability that you are going to have to have to attain enforcement for some of the rules and regulations that you may promulgate. The only way you can get that creditability is to communicate directly, often, and very intensively with the fisheries that you plan to manage.

This may require a slower management development process. But, you do have to get out and do some preliminary leg work and survey work with the people in the industry. You have to find out who the best marketing people are, who the best producers are, who the highline fishermen are, who the people out in the industry that know that resource base throughout its imaginary range are. You have to get their names, their addresses, their telephone number, and you have to use their knowledge because quite often the knowledge you will get from other sources will be extremely different.

The data collection capabilities are seriously lacking in most of the fields. The economic and the sociological analysis is extremely poor at the present time. In most of the fisheries that we look at the landing status are off by fifty percent, on the low side. For small boats in the thirty, forty-foot range using gill nets, four or five of these little vessels can produce as much as the larger stern trawlers of the U.S. size. The amount of fish production that comes in from remote out-of-the-way places is strickly on a cash-on-the-barrelhead basis in most cases. These fish are distributed by any number of peddlers, and the statistical collection capability for these resources is very limited. And that will create a serious problem for those of you who feel you have to come up with hard numbers because you will find that the better the statistical collection system, the greater amount of fish are being caught, and you will have to live with that problem for quite a while.

The term optimum yield was designed the way it is -- I won't say on purpose -- but, it was a blend of what a lot of people felt their responsibility should be. Basically, from the standpoint of the fishermen themselves, optimum yield is different for every individual. In most cases, people will make what they want to make, or the income that is suitable to them. A group, or a of a group, will have a much different perspective of what optimum yield is for that group. That's going to be your job, to sort out among all these various participants what the maximum sustainable yield and the optimum yield will be.

The point I want to make is that the primary management responsibility is yours. You are going to have to work very closely with the industry to get the credability you are going to need to make your decisions stick. If there is anything that fishermen are very good at it is coming up with alternative methods to avoid regulations. Even the best rules and regulations can be circumvented. If the whole process is going to work, it is going to have to work more or less on the honor system. The only way that will happen is if you maintain the credability with the industry that you are going to be regulating.

Lee Weddig

Executive Vice President, National Fisheries Institute

I have a new definition of optimum yield based on the discussion this morning. It is that amount of fish that enables a processor to operate his plant at precisely 105 percent capacity, which plant is the only one able to process the fish in question, and which fish also is in such tremendous demand by consumers both here and abroad that it is in perpetual short supply. If you can work that out, our group will be very happy.

The comments that I would like to make, in seriousness, on arriving at OSY from a processor-marketer point of view is that the overriding need is one of stability.

The investment in plant, the long-term requirements for developing distribution channels, the very rapid way one can lose position on retail shelves, the rapid manner in which items can be dropped from restaurant menues, make changes in the processing and distribution pattern extremely costly and disasterous. For that reason, from our point of view stability becomes the most important factor to consider in OSY determinations. We must be able to plan on access for an extended period. So, we would caution the planners against precepitous changes, and express the desire to make even modest changes on a controlled basis.

To illustrate, I think we need only look at the current controversy that is taking place in the North Pacific Council, where there is a possibility, or at least a suggestion, that foreign processing plants be established within the 200-mile zone, and the concern on the part of people who would like to invest in that area that they would not be able to do so in the face of such competition, mainly because of the long-time planning process and the investment process that is necessary to go into major planning and development. I think this illustrates why we would be against that sort of operation. But, it really shows more importantly the need for stability in the resource.

We have talked about social factors that affect the OSY determination. I would like to point out the social factor of all 210 million consumers must be recognized by the Councils. They have the right to have access to fish whether they live in Iowa or are able to catch it from the shores of Massachusetts, or elsewhere. In addition, there are the social factors of many other people whose livelihood depends on the commercial harvest. That should be recognized.

I think you are all familiar with the tremendous resurgence and specialization in fish and sea food marketing in the country in the last five to ten years. This is a fantastic investment and represents livelihood for many more people than are involved directly in catching and processing of fish. The social factors of this part of our economy must be recognized also.

The sea food restaurants, perhaps, can be converted to chicken places. But, we have got plenty of chicken places, too. Restaurants that have been established just to serve fish represent a very large portion of a burgeoning fast-food industry.

I would like to also point out, as we debate the definition of OSY, the fact that it can be turned against our people as well. Chris mentioned the tuna fleet. I would like to mention the shrimp fleet based in South Texas and Florida.

As we inject into the determination of OSY all sorts of factors that go well beyond maximum sustainable yield, it makes it extremely difficult to argue with Mexico, Brazil, and other nations, that our fleets should not also be treated in the same fashion.

I believe I could construct a fairly decent argument for the Mexican government as to OSY for the shrimp catch off the shores of Mexico that would be far less than MSY. Of course, this means that our shrimp fleet would be phased out faster and more permanently than it might be looked upon right now.

So, what we do here in determining how OSY is to be determined, is also going to work against a large part of our fishing community.

We talked this morning about the matter of determining demand. I would like to suggest that is far more complex than perhaps any of us realized. We talked about assigning a value to the product in the marketplace. We have to recognize that there is no U.S. market by itself, with a few exceptions. We are in a world market, and we cannot forget that. If one is to adopt one of the suggested management goals of providing cheap fish for the consumer, we are just going to fail. There is no such thing as cheap fish any more. And all we are going to do, if we set up a scheme to provide cheap fish for our consumer, is to make the trading companies very rich because the vacuum for fish around the world is what is going to determine the value on the product. If we do things that are going to make fish cheap here, all that is going to mean is that someone is going to be able to buy it and sell it in parts of the world where he can get more money, far more than we are willing to pay. We have to look at the world market, unless we want to get into a completely controlled economy -- that is, control imports and exports completely. We are a free trading nation by basic philosophy. So, unless we want to do that, we really have to look upon the value of the product as it is placed in the world market.

I do not think we are going to be able to do that very sophisticatedly at this point. I would not feel that we should spend too much time trying to fine tune the value of the product down to the last three cents a pound because it just doesn't make any sense whatsoever.

Finally, I think that our best bet for OSY, at least from the processing viewpoint, is to try to keep it as simple as possible and concentrate on what I believe is the most important thing. That is to preserve the resource, the conservation aspect, and make certain that it remains with us for both commercial and recreational purposes year after year.

The plan must make certain that there are no gross injustices to any people.

I think the more specific parts of the economics, the social factors, the ecology are going to work themselves out if we concentrate on maintaining the resource, and avoiding gross injustices. I think the rest will kind of fall into place by itself.

Finally, I say leave it to the Councils.

Christopher M. Weld

Executive Vice President, National Coalition for Marine Conservation

The Fishery Management and Conservation Act says two things up front and loud and clear. First, fisheries managed pursuant to the Act shall be managed in accordance with management plans which conform to the national standards.

Second, such plans will achieve and maintain on a continuing basis optimum yield from each fishery. I want to emphasize these three little words "from each fishery," because from the point of view of the recreational fisherman, there probably is no species of fin fish likely to come under a management plan which is not the subject of some degree of recreational fishing interest.

The recreational interest may be obvious and direct, as in the case of target species such as striped bass and king mackerel, or it may be indirect with little or no recreational fishing effort directed upon the species, as in the case of anchovy, ballyhoo, menhaden and mullet. However direct or remote, the recreational fishing interest must, as a matter of law, be taken into account for the purposes of determining optimum yield. And, any plan which fails to do so reasonably and equitably is subject to challenge for failure to comply with the national standards.

The definition of optimum yield is intentionally vague. It is described both as an objective and as a formula for achieving an objective. Thus, on the one hand, it is said to relate to "that amount of fish which will provide the greatest overall benefit to the nation," while on the other hand, it is said to be maximum sustainable yield "modified by any relevant economic, social, or ecological factor."

It also involves assurance that food and recreational benefits may be taken on a continuing basis, that long term adverse affects on fishery resources shall be avoided, and that a multiplicity of options for the future use of the resources will be preserved.

The committment to conservation is also up front and loud and clear. Domestic commercial and recreational fishing are to be promoted under "sound conservation and management principles."

Don McKernan remarked the other day that he thought that the words "conservation and management" were redundant. Evidently, he has chosen to overlook the fact that at the time the concepts now embodied in the Act were being assembled, compromised, and translated into statutory language, MSY and management appeared to be synonymous in the minds of many fishery bureaucrats. Fishermen, on the other hand, tended to regard MSY as the smoking gun of mismanagement. Therefore, the constant repetition and careful definition of the term "conservation and management" was an explicit and unmistable negation of MSY, except as it is used for determination of a maximum number or outside catch limit to be pummelled, sweated and pared by the OY process and trimmed again in accordance with Standard 6 of the national standards.

The recreational fisherman's right to a reasonable share of fishing privileges under a plan for the management of a species that is a target species for both commercial and recreational fishermen is guaranteed by Standard 4, which requires that allocations be fair and equitable to all fishermen.

The complicating factor that promises to make most such allocations excruciating is the fact that, for commercial purposes, fish are usually said to recruit to the fishery at maturity, whereas the recreational fisherman is mostly interested in older fish that are bigger and stronger. These are usually referred to as "trophy-sized fish." The disparity in age between marketable fish and trophy-sized fish is often very great.

Assuming that in the normal course of events fisheries will not come to the attention of the Councils until they are fully utilized or over-exploited, allowing fish to escape to the trophy-size year classes will entail a reduction of effort on the part of commercial fishermen.

All manner of socio-economic inputs may be helpful to the decisionmaking process, but in the last analysis determining the degree of reduced effort in the amount of escapement will involve subjective judgments of fairness and equity painful enough to the conscientious voting Council member to earn him his meager stipend.

In my opinion, the thrust of Standard 4 is unequivocal, and requires a level of fishing in mixed fisheries which will be significantly less than MSY.

Seandard 4 speaks of "fishing privileges," an undefined term. What does it mean? It is currently fashionable to say that the output of sport fishing is not fish, but fishing, or that anglers go fishing to seek satisfaction unrelated to the catching or eating of fish.

While these conclusions serve as useful copouts to economists asked to quantify the value of the recreational fishing experience, they ignore the obvious reality that in the absence of a reasonable expectation of catching a trophy-size fish nobody would go fishing.

Companionship, escape, adventure, the outdoors, and a day on the ocean, and all the other values sociologists speak of as recreational fishing motivations, can be found in a sailboat. It takes a fish to send a man fishing -- probably more than one, given the ever-increasing cost of a day's fishing.

For these reasons, and on the basis of the recreational fisherman's common law and constitutional right to fish, I submit that the term "fishing privileges" means fishing in the sense of catching and harvesting -- but not necessarily selling -- fish.

The management objective in a mixed recreational and commercial fishery should be to maintain population densities in every year class sufficient to sustain the reasonable expectations of recreational fishermen. Obviously, commercial fishermen must necessarily bear the economic consequences of whatever restraints are required to achieve and maintain the desired population structure.

However, to the extent that it is equitable to do so, recreational fishermen can be made to bear a share of the burden through closed seasons and daily bag limits.

Let's look now at the indirect interest of recreational fishermen and key prey species. The angler's entitlement to consideration when allowable catches are determined is carefully spelled out in the Act. Remember those three little words? Standard 1 dictates that conservation and management measures promulgated pursuant to any fishery management plan shall achieve the optimum yield from each fishery. The work "optimum," as you will recall, refers to the greatest overall benefit to the nation with particular reference to food production and recreational opportunities.

The recreational benefits associated with, say, the menhaden relate to its ability to attract and hold predators. But, this is not merely a social or socioeconomic consideration which must be weighed in determining the optimum yield of a particular stock of menhaden. It is also a basic ecological input.

Fishery bureaucrats habitually brush aside considerations of predator-prey relationships and their affects upon angler success as being functions of natural mortality outside the scope of their concern. At the recent Marine Recreational Fishing Seminar in San Francisco, Dick Hennemuth said that he doubted that the size of the standing population of predators could be manipulated by controlling the fishing effort on prey species.

I assume what he meant is that large predators are sufficiently mobile and non-selective so that if they can't feed in one place or on one species, they can feed somewhere else or upon something else.

Nevertheless, and this is not inconsistent with Hennemuth's observation, any thoughtful angler will tell you that shifts in fishing strategy on prey populations will have noticeable local impacts on the availability of predators.

In any event, it seems to me quite logical to suppose that where the biomass in a given area is reduced by sixty to eighty percent or more, the area occupied by the biomass will shrink or shift, and the pattern of predator movement will change accordingly.

Unfortunately, state and federal fisheries administrators are to look upon many prey fishes as "latent resources" or "underutilized species," and tend to reject out of hand the possibility that the highest purpose, or the greatest benefit to the nation, of such species is to sustain another species, or otherwise maintain a balance in the ecosystem.

It should be recognized that there is no obligation to harvest a species just because it's there. To quote Larkin, "After all, if you think about it, there is a good crop of robins to be harvested, and a potential yield from cats and dogs, if protein is the only consideration."

It is worth noting that while the Act speaks of promoting commercial fishing, it makes no reference to the concept of maximum utilization, a LOS concept which was invented, so far as I can tell, for the exclusive benefit of the San Diego tuna fleet.

In closing, I would like to comment upon the Secretarial guidelines promulgated by NOAA for the purpose of interpreting optimum yield. The guidelines state that optimum yield, "permits management on the basis of MSY if the need for fisheries products is overriding."

To me, this is a touching demonstration of the loyalty of man for his dogma. But, it is completely at odds with Standards 1 and 6.

Having taken a number of species to the brink of extinction in the interest, supposedly, of detente, avoidance of international confrontations, and the need to make sacrifices to various other sacred cows worshipped by the State Department, the Department of Defense, and the American Tuna Boat Association, it is inconceivable to me that anybody would be willing to go that route again. In any event, if this guideline is to be taken seriously, the question must be asked, "Whose need for fisheries products is overriding -- the nation's, the consumer's, or the commercial fishing industry's?"

Obviously, in the context of a national emergency, the rules get jetisoned first. But, I submit to you that nothing short of a national emergency should lead us down the garden path to MSY management again. While it is up the Councils to determine optimum yield on a case-by-case basis, they will ignore the socio-economic and ecological factors dear to the hearts of recreational fishermen, only at the cost of seeing their plans rejected or rewritten by the Secretary.

Data Needs and Problems In The Consideration Of Optimum Yield

Chairman, Donald E. Bevan:

Acting Dean, College of Fisheries

University of Washington

Member, Scientific and Statistical Committees

Pacific and North Pacific Fishery Management Councils

Quite a bit has been said about data already. I do think that perhaps in this next few minutes that we spend on the subject that we might tackle a free for all between the users of the data and the people who collect it and manipulate it in a provable way. We have got quite a number of those in the audience. I would hope that we can lead this to some discussions that would be helpful in focusing our attention on our data needs.

It is not too difficult to look at data in general and say, well, it's not too difficult a problem. It's a question of what kind, how much, how accurate, how precise and, then, go on and list all kinds of numbers of things out of the harvesting sector, the processing sector, international trade, and various kinds of social and economic parameters, and so on.

I don't think that is very useful at the present time. I might suggest that we can go back and look at history, at what we gathered, and say that that probably was not a bad priority.

Usually we have first gone after catch, then catch per unit of effort, then effort, then any number of measures of costs and benefits. And I suggest that barring any immediate need, that isn't a bad list of priorities.

We have brought up the question of recreational statistics. And I think perhaps it is worth spending a little more time on that. I think it is an important problem and one that is going to attract more of our attention.

Jimmy Crutchfield told of the difficulty in using some of this data. I think most of us will recognize that people keep better records when dollars are involved. It is just human nature to keep track of dollars.

Now, data, I think, is the best reason for a sport fishing license. Let me suggest that people gathering data can do a much more efficient job if they know about the population from which that data comes. It is the very best way to efficiently gather data if you have some general idea of the distribution of that population. Without a fishing license, it is very difficult, and often very expensive.

I would suggest, a little bit facetiously, that those of us who earn our living by manipulating data ought to do something with the recreational data like the airline pilots do. They give you a list of airports around the country with gold stars, yellow stars, and red stars. And the public knows from the group of rather educated users of those airports that if you go into Anchorage or Boston or Portland, or some other cities, that you have a significantly greater risk, and if you go into the Virgin Islands it might be downright dangerous.

I suspect that we ought to look at states and their data gathering systems and put some red stars on the states that don't have fishing licenses and yellow stars on something like the several that asks you to list things on licenses, and you can make a judgment that you could use statistics from California with a minimum of risk, that it's a little more hazardous to get them from the State of Washington, and in Florida it may be dangerous. Perhaps we'd spur things along by making people recognize that we can get better data with a licensing system than we can without one.

One of the major things that came up in our technical session earlier concerning data was putting the cart before the horse. It is very easy in dealing with information to do just that. And I think Lee Alverson suggested this morning that we not wait for all the information to come in, go out and devise schemes for all kinds of economic and social information, and wait to make some decisions or decide what our objectives might be until that information is in front of us. I think here is where the Councils are going to have to make some decisions at the outset and give us some concrete objectives.

As I said in one of the technical sessions earlier, I don't need to have quantifying numbers on the importance of these objectives. I would be very, very happy if they would indicate the value of the sign. If I knew the Council was interested in plus, minus, or zero in a particular category of information, I could go much better prepared to provide some tools to evaluate those objectives.

We have had quite a lot to say about models. My own personal view is that in gathering data and devising systems for gathering data, that modelers can be of great value. They can tell us something about the sensitivity of their models to the various kinds of data. Somebody said this morning that we should look at the tackle box and divide by twenty-seven. And someone else said it was twenty-six. The truth is maybe whether you divide one or twenty-six or twenty-seven, it doesn't make that much difference. That kind of information can come out very clearly from a model that might not be very accurate in relation to real life.

Lee Anderson said earlier, I thing quite well, that objectives must come first, and the system of data collection comes afterwards. But, once you see the data, you may want to change your objectives. And I think that is fine. On the other hand, it would be a mistake not to provide researchers such as Mike Orbach with the data which would allow them to do fundamental research on issues that are not well understood in anthropology and various other social sciences.

It seems to me to be a mistake to wait around for all the answers to come before we take some action. This is an experiment in government, a new form of government, as I have said before. We are looking at a number called optimum yield in which the Councils will wish to put in inputs that are not easily quantified. And you really shouldn't take its accuracy all that seriously. If it isn't right this year, hopefully we are going to find out next year, or the year afterwards, and be able to make some modifications.

So, I think we have a two-edged sword. The data is expensive. It's hard to get. We can't get everything that we want to. Let's get the first things first.

General Problems In Fishery Management Plan Development

With Reference To Optimum Yield

Chairman, William G. Gordon

Director, Northeast Region

National Marine Fisheries Srrvice

Member, New England and Mid-Atlantic Fishery Management Councils

As you may know, when you are talking to a fisherman, optimum yield to him is the height of his desire. To the Government, OY may be full utilization. These two things, and many others, may not go together. I see a lot of problems with optimum yield both from the longer term, as well as from the shorter term.

Looking at the plans I have been responsible for, and have worked with, I can name a few of these problems. I suspect a number of these may have come up in the course of the week here.

One of the things is that when you try to define optimum yield for the U.S. fisherman for 1977, what comes back to haunt you later is the distribution of the fish. For some reason, the fish don't go along with optimum yield. Fishermen have a way of changing their own distribution. American fishermen often find that they want to catch fish when they are at the shore side, in traps, or other highly productive mechanisms in terms of catch per unit of effort, for the seasonal period when the fish are concentrated for spawning, or whatever.

To use an example that we must deal with in the very near future, we can talk about the squid.

Last year when we were defining what optimum yield would be to the American fisherman, he said he wanted 37,500 tons of two species of squid in the Northwest Atlantic, and that he knew he could sell these. The foreigners, who had been harvesting the bulk of these species before, were dismayed that we would ask for so much inasmuch as prior history showed we had taken about 4,000 tons each year.

Everyone geared up. There was a traveling group that went to Spain, Japan, Italy, and so on. And it signed sales arrangements to sell squid.

No one told the squid he was supposed to show up in the Long Island Sound, or the Nantucket Sound this spring, and he didn't. Production has been less than 3,000 tons. And the season is basically over for these squid in terms of moving ashore.

So, unless our fishermen change their technology rapidly -- I will explore that later -- it will not be possible for us to come anywhere close to that. And we are faced with the task of telling the foreigners sorry, or to reallocate, causing other problems.

Another problem I think we have is distribution. Fishermen have the habit of being cantankerous. When they want to go home, they go home. And if the fish are to be caught, the fish can wait. And if they don't come back, well, so be it.

I remember one public hearing we had on what optimum yield would be. And a fisherman was telling how good the fishing was, and how much money he was making, and how he had decided to go home. We asked him why he went home. And he said because his wife wanted him to. He didn't bother to come back even though he was potentially grossing about $20,000 worth of fish a day and making a good profit.

Another thing I think is going to be a real problem in determining optimum yield is the attitude not only of individual fishermen and processors, but of the towns and cities who will either have to expand harbor facilities and accept new construction on the waterfront or somewhere else. What do they want in terms of social goals? Some of these towns and cities are substantially different from individual fishermen who may live there, or the processor who wants to build ther or plan his facility there. The tradition that is so deeply engrained in many aspects of fishing culture, the structure of the industry -- these will vary greatly, I think you all recognize, from fishery to fishery.

For example, think about all the different U.S. fisheries, from salmon, to tuna, to shrimp, to groundfish. Then think about the traditions, attitudes, and strategies of companies like Gorton's, Mrs. Paul's, and those who demand large volumes of quality fish in order to continue their operations. Try to fit these attitudes and traditions together to achieve what might come out of the calculations as an optimum yield.

You know, I joined the fishery service some years ago. I used to hear people talk about models. And I kind of always think of Bridget Bardot. They say they have to develop a model. I have been trying to develop one like that for a long time. And I always get Twiggy.

I think that's the way the models that you were talking about earlier probably are. They may be long and tall and skinny, and they are going to be that way for a long time until we fill in the high points with some of this data we talked about.

Another point that I see as a practical problem is government intervention. We all want to achieve optimum yield for the nation. But, there are other aspects. The government is going to constantly intervene, not only our government, but someone else's government. Another practical problem is rapidly changing world economics. When we started on the plan development hearings, for example, world prices were one thing. U.S. prices were another thing. Early this week, when I was up in Canada for the discussions on the future of ICNAF, I had people coming up, saying, "We will buy 60,000 tons of herring. And we are now willing to pay $125 a ton." Last year it was $70 a ton. Right behind them comes another contingent saying, "We will meet that price and go better."

We are almost into an auction system, as the various world fishery people vie for the opportunities to buy fish from us, which, again, will change the needs of the American fisherman with respect to OY.

One thing that you can't calculate and which presents a very practical problem is the labor situation. They go on strike, there are work stoppages, this sort of thing. And it can grossly affect the outcome of your calculations for optimum yield.

Another practical problem is the competition for space on the ground. When I left Boston to come down here yesterday, I noticed an item in the paper, "Why don't we set aside areas out there for sport fishermen, exclusively for the use of sport fishermen?" It was written by the sports editor in one of Boston's papers. Politically, I expect this sort of thing might happen, particularly inside three miles. Many fish do not recognize where three miles is. This can happen very rapidly in some states. And this will have a tremendous effect on the capability of the industry to harvest what we might call optimum yield.

We also, I think, have to accept the economic realities that the fisherman is a mini computer. You put together a plan. You calculate optimum yield. And the fisherman immediately begins to trade off whether he catches herring today, or mackerel, pollock, crabs, and so on. He is a very adaptable creature, and he plays a market for his products. And we are not managing him in that economic sense. We are not going to control him.

U.S. fishermen, as we all know, are, by and large, individuals. They are not large corporate firms that can control the individual boats. The captain, when he sails, fishes for whatever strikes him for that day. One of his considerations is what he thinks the market will give him the better price for. These are practical problems. I don't know quite how to deal with them given the present structure of the industry.

I am sure earlier in the week you talked about economic capacity. That to me is probably the most difficult figure to define. Engineering capacity is pretty easy to define in many respects. We look upon it as being principally the technical properties of capital equipment, being able to catch and process.

If you take the economic aspects, the labor aspects and try to fit it all together, I see real practical problems coming out. Very important to me is the definition of recreational capacity of the recreational fisherman. I am talking about more catch per unit of effort in preserving the option to catch fish. That's going to vary obviously from fishery to fishery. It's going to be an extremely difficult problem to deal with.

I am sure you also used the term -- or at least it creeps into economic jargon -- inadequate demand. I don't think there is any fishery commodity in the world today where there is an inadequate demand. I don't think there is anything that is harvested with traditional harvesting gear that is not in danger of being over-fished, and that the demand is not there to accommodate it somewhere in the world.

If we look upon part of the challenge of optimum yield as putting the exploiter and the consumer together for the benefit of the United States fisherman, very rapidly our problem will become full utilization. Then, it becomes the internal concern of the United States to allocate among the competing user groups. I do not want to talk about that for any length. But, it is going to be a reality in my view in the very near future.

The same problems that we saw on the horizon a very short time ago, I think, are no longer with us. I didn't bring the article with me but I wish I had because it was very good reading. I have good news: the two hundred miles has already paid off in New England. The foreigners were chased out on March 1. All the fish have grown up and are now being harvested by U.S. fishermen. Then, in an interview with Channel 7 of Boston, a TV station, a fisherman from

New Bedford, or Gloucester, who are extremely vociferous, said he wished for the good old days when the Russians were here. We are catching too many fish now. The price is down. We are not making all that money any more. And we got to do something about it. Maybe we ought to let them back in a little more. I'll stop right there, but that seems to be the greatest practical problem we have to contend with.

I think one of the bigger problems is that pointed out by Bill Mustard; effective communication with the fishing constituency, whether they be the recreational fishermen or the commercial fishermen.

We also have a problem in dealing with the consumers. We don't have an effective channel in dealing with the consumers. At least, one has not been established that has been truly effective. And where this responsibility lies, I'm not really certain. It's clearly a responsibility within the Councils to establish good communications with the public, particularly the fishermen. The advisory panels give us that opportunity to some degree. But, we have to go beyond that because that's only on a small portion of the people out there.

How do we get across the message to the public? How do we break down these attitudinal positions that many people have deeply engrained? How do we satisfy a group without upsetting important economic and social structures, and ensure that the U.S. fishermen will be able to take advantage of opportunities?

Currently, I don't see any change in the amount of fish the U.S. imports. I see changes coming very fast in terms of what we export. But, it strikes me that many of the things that we import the American fisherman could produce, probably as cheaply given some strong incentives and a push in that direction within the very near future. I am thinking of such things as Alaskan pollock, where we invite foreign flag vessels to harvest and process them and ship them around to the East Coast and run them through the plants where they come out as fish sticks and portions.

White and silver hake is another species where we have a tremendous potential on both coasts. Yet, it is one of our biggest import items from South America and South Africa. I think these possibilities should all go into the equation of optimum yield.

As a last point, I would like to mention joint ventures. Perhaps this is a good place to throw it out -- what is the proper perspective with which to look at joint ventures? In some views, if you look at it in the short term, American fishermen might be able to quickly catch much of the stocks that we are talking about.

What stand do we as a government agency, or we as a Council, take on some of these positions? We know there are several bills before the Congress that will soon be addressed. I am curious, because if they should act hastily, we can do irreparable harm. But, If we act more slowly do we establish some precedents that come back to haunt us in the longer term?

I feel that this is the time to take this problem before the fishing public in a fact-finding type of session to discuss it openly and candidly wherever we can, to try to obtain the views and to get across the views of different sides.

You can look at it this way: that members of the Councils may be for it, they may be against it, depending on the positions that they occupy as private citizens: or from the point of view of state representatives, in which case the Council might quickly find itself in what could be determined some conflicts of interest. It may be that it is not the prerogative of the Council to hold these public meetings. Maybe Commerce should do it alone, with Council people free to come and participate and make their views known.

I just throw this out for discussion. To me, it should be thought through very carefully.

CONTRIBUTOR AFFILIATIONS

Alverson, Dayton L.	Director, Northwest and Alaska Fisheries Center, National Marine Fisheries Service; Member, Scientific and Statistical Committees, Pacific and North Pacific Fishery Management Councils
Anderson, Lee G.	Associate Professor of Economics and Marine Studies, University of Delaware; Member, Scientific and Statistical Committee, Mid-Atlantic Fishery Management Council
Apollonio, Spencer	Executive Director, New England Fishery Management Council
Bevan, Donald E.	Acting Dean, College of Fisheries, University of Washington; Member, Scientific and Statistical Committees, Pacific and North Pacific Fishery Management Councils
Bledsoe, L. J.	Research Assistant Professor and Program Director, NORFISH Sea Grant Program, Center for Quantitative Science in Forestry, Fisheries, and Wildlife, University of Washington
Cato, James	Food and Resource Economics Department, University of Florida; Vice Chairman, Scientific and Statistical Committee, Gulf of Mexico Fishery Management Council
Collinsworth, Don W.	Department of Fish and Game, Alaska; Member, Scientific and Statistical Committee, North Pacific Fishery Management Council
Cronin, L. Eugene	Associate Director for Research, University of Maryland Center for Environmental and Estuarine Studies; Member, Scientific and Statistical Committee, Mid-Atlantic Fishery Management Council
Crutchfield, James A.	Professor, Department of Economics, University of Washington; Member, Pacific Fishery Management Council
Dammann, Arthur E.	Director, Bureau of Fish and Wildlife, Virgin Islands; Chairman, Scientific and Statistical Committee, Caribbean Fishery Management Council
Devanney, J. W., III	Associate Professor of Marine Systems, Massachusetts Institute of Technology

Eldridge, Peter	South Carolina Marine Resources Institute; Member, Scientific and Statistical Committee, South Atlantic Fishery Management Council
Gordon, William G.	Director, Northeast Region, National Marine Fisheries Service; Member, New England and Mid-Atlantic Fishery Management Councils
Loh, Low Lee	Fishery Research Biologist, Northwest and Alaska Fisheries Center, National Marine Fisheries Service
Lokken, Harold E.	Fishing Vessel Owners' Association, Inc.; Vice Chairman, North Pacific Fishery Management Council
Lyman, Henry	Publisher, Salt Water Sportsman; Chairman, New England Fishery Management Council
McKernan, Donald L.	Director, Institute for Marine Studies, University of Washington, Member, North Pacific Fishery Management Council
Mustard, William	Tilghman Marine
Orbach, Michael K.	Social Anthropologist, Fishery Management Operations Division, National Marine Fisheries Service
Peterson, Susan	Research Associate, Marine Policy Program, Woods Hole Oceanographic Institution, Member, Scientific and Statistical Committee, New England and Mid-Atlantic Fishery Management Councils
Rothschild, Brian J.	Director, Office of Policy Development and Long-Range Planning, National Marine Fisheries Service
Shomura, Richard S.	Director, Honolulu Laboratory, National Marine Fisheries Service, Vice Chairman, Scientific and Statistical Committee, Western Pacific Fishery Management Council
Siegel, Robert A.	Staff Economist, Fisheries Management Operations Division, National Marine Fisheries Service
Sissenwine, Michael P.	Fishery Biologist, Northeast Fisheries Center, National Marine Fisheries Service

Smith, Courtland L.	Associate Professor, Department of Anthropology, Oregon State University
Smith, Leah	Marine Policy Program, Woods Hole Oceanographic Institution; Chairman, Scientific and Statistical Committee, New England Fishery Management Council
Spaulding, Irving A.	Professor, Department of Resource Economics and Rural Sociology, University of Rhode Island
Stroud, Richard H.	Executive Vice President, Sport Fishing Institute; Member, Scientific and Statistical Committee, South Atlantic Fishery Management Council
Tse, Edison	Assistant Professor, Department of Engineering-Economic Systems, Stanford University
Weddig, Lee	Director, National Fisheries Institute, Inc.
Weld, Christopher M.	Executive Secretary, National Coalition for Marine Conservation

☆ U. S. GOVERNMENT PRINTING OFFICE : 1977--261-238/417