CANADIAN FISHERIES REPORTS

No. 4 MAY 1965

THE DEPARTMENT OF FISHERIES OF CANADA
OTTAWA

CANADIAN FISHERIES REPORTS

No. 4

May 1965

Published at Ottawa by
The Department of Fisheries of Canada

ROGER DUHAMEL, F.R.S.C.
Queen's Printer and Controller of Stationery
Ottawa, 1965

Cat. no: Fs4-24/4

CONTENTS

This issue of *Canadian Fisheries Reports* is made up entirely of the proceedings of a symposium on The Economic Aspects of Sport Fishing, held in the Chateau Laurier, Ottawa, January 5-7, 1965, sponsored by the Department of Fisheries of Canada. The symposium was arranged and conducted by the Economics Service of the Department.

IV—STATISTICAL NEEDS

SUMMARY OF SYMPOSIUM

Canadian Fisheries Reports is published under the authority of the Minister by the Department of Fisheries of Canada, as a means of providing for circulation of specialized information of interest to the fishing industry, from the primary enterprise to the end product. Articles may deal with conservation, inspection, development, economics and related subjects. Responsibility for statements made or conclusions reached in published articles remains with the authors. Those who wish to discuss articles herein are encouraged to do so, and space will be made available in future issues. Correspondence should be addressed to the DIRECTOR, INFORMATION AND CONSUMER SERVICE, DEPARTMENT OF FISHERIES, OTTAWA, CANADA.

Published under Authority

of

HON. H. J. ROBICHAUD, M.P.
Minister of Fisheries

FOREWORD

Background to the Symposium

The Federal-Provincial Conference on Fisheries Development held in January 1964 at Ottawa went on record as recognizing "the tremendous and increasing importance of sport fishing" and stated that in bringing about greater productivity and efficiency in the fishing industry account also be taken of the sport fishery. The Conference also recognized that the promotion of sport fishing was generally a provincial matter, although the federal government has responsibility for managing anadromous species and, in some provinces, other species as well.

As an outgrowth of the Conference, it was decided that a Symposium should be held on the economic aspects of sport fishing. It was found that little work had been done on these aspects in Canada, and that which did exist was the work of individuals or agencies working independently and was largely unco-ordinated. The Symposium was not expected to produce detailed step-by-step procedures for the economic evaluation. Instead, it was intended to provide for an exchange of ideas and to serve as a starting point for future investigations and discussions on the evaluation and other economic aspects of sport fisheries.

The Symposium was not to consider recommendations or resolutions, nor to serve as a forum for the presentation of briefs.

Participation

Participation was invited from the interested agencies of the federal and provincial governments, from universities, and from other agencies which have undertaken research in this field. Participants represented a cross-section of the persons working in this field including biologists, administrators and economists. Because of the similarity of the problems, attendance also included persons whose main interest has been connected with other forms of wildlife and with recreation as a whole.

Three categories of participants were established:

(*a*) Panel members—persons who were invited to prepare papers, or otherwise to fulfill a formal role at the Symposium,

(*b*) Invited participants—persons with a direct interest in the problems being discussed and who would contribute to the discussion, and

(*c*) Observers—persons with an indirect interest in the Symposium.

Acknowledgements

Included in these proceedings are eight formal papers on the subject of sport fishing. These deal with a variety of aspects important to the development of sport fishing as a form of outdoor recreation. Six of the eight papers were prepared by

persons outside the Department of Fisheries. Appreciation is expressed to Dr. Marion Clawson of Resources for the Future Inc.; Professor Anthony Scott of the University of British Columbia; Mr. William M. White and Dr. Lionel Walford, both of the Fish and Wildlife Service, U.S. Department of the Interior; and to Dr. T.G. Northcote and Dr. Norman H. Morse, of the British Columbia Department of Recreation and Conservation and of Acadia University, respectively, for their contributions which, together with those of Mr. R.A. Spargo and Mr. A.L.W. Tuomi, both of the Department of Fisheries, form the bulk of the record of the Symposium. We are especially appreciative, knowing that the preparation of papers represented an additional effort on the part of these eight gentlemen over and above their normal duties.

As will be evident, the summaries of the panel discussions, in the absence of verbatim reporting, cannot do justice to the intelligent comment, observation and questioning which constitute so much in a meeting of this sort, nor to the contribution which specific individuals made to these discussions. Nevertheless, these summaries, in providing a description of the general points of discussion and the areas of agreement, as well as those of divergence, constitute a vital part of the documentation of this Symposium. A special note of thanks is due to the two teams of reporters (each team consisting of a biologist and an economist) in their efforts to distill the discussions of the panels into an abbreviated, yet meaningful, form.

We are especially grateful to persons who served as panel chairmen, or as members of the various panels; and to the persons who, although they had no formal role at the Symposium, actively participated when discussions were thrown open to the audience.

Special mention is to be made of Dr. P.A. Larkin's contribution to the Symposium. The original program called for a considerable contribution on his part —as the chairman of the first panel and as a member of another panel. Due to circumstances, it was also necessary to impose upon Dr. Larkin the onerous task of summing-up the entire meeting.

In conclusion, the above appreciations would be seriously deficient without mentioning the special credits due to the members of the Secretariat (listed in Appendix A) who were called upon to handle the many administrative details of the Symposium.

J. B. RUTHERFORD,
General Secretary

OPENING SESSION

Sport Fishing in the Economy of Recreation

(Held jointly with members of the Fisheries Research Board of Canada, January 5, 1965, 2:00 p.m.—3:15 p.m.)

Joint Chairmen

A. W. H. NEEDLER,
Deputy Minister,
Department of Fisheries of Canada,
Ottawa, Ont.

F. R. HAYES,
Chairman,
Fisheries Research Board of Canada,
Ottawa, Ont.

Main Address*

Economic Aspects of Sport Fishing

by

MARION CLAWSON,
Resources for the Future,
Washington, D.C.

Special Guests

E. A. CÔTÉ,
Deputy Minister,
Department of Northern Affairs
and National Resources,
Ottawa, Ont.

P. A. LARKIN,
Director, Biological Station,
Fisheries Research Board of Canada,
Nanaimo, B.C.

**delivered in Dr. Clawson's absence by Dr. Jack L. Knetsch, also of Resources for the Future.*

Opening Remarks by Joint Chairmen

A. W. H. Needler:

It is my pleasure, as joint chairman with Dr. Hayes to open this Symposium on the Economic Aspects of Sport Fishing. We are very pleased to have so many distinguished visitors with us from various parts of our own country and from across the border. We are also pleased to see the Deputy Minister of the other Department interested in the sport fishery, Mr. Ernest Côté, of Northern Affairs and National Resources, with us.

Everyone in this room is well enough aware of the importance of sport fishing, to make it unnecessary for me to elaborate on this matter. However, I think that some background might be useful. The Department of Fisheries has been well aware for many years of the problem of reconciling the regulation of fisheries for commercial purposes with that of providing for the sport fisheries. While it is perhaps relatively easy to assess the value of the commercial fisheries to the community—admittedly even here, there are lots of opportunities for exaggeration, or for overlooking some particular ancillary value—it is very difficult, indeed, to do this for sport fishing.

The reasons for this ought to be immediately apparent. For one thing, the recreational value itself is very difficult to assess; and I am sure to all of us, or to a great many of us who indulge in sport fishing, this is the important value. Then sport fishing supports an industry as does commercial fishing. The assessment of the value of this industry to the community is very difficult because it is difficult to assess the importance of sport fishing in the development of the tourist trade, and of various aspects of our economic life which are connected with sport fishing. In such assessments, the importance of sport fishing might be exaggerated, or it might not be fully appreciated. Yet, in the long run, if we are to regulate fisheries to the greatest benefit of the people of Canada, we must have some comparison of the importance of certain stocks of fish for commercial purposes and for sport fishing. Many of us will know of a number of instances in which this controversy, as one might call it, is very obvious. There are some cases where for the protection of the sportsman, commercial fisheries have been unreasonably curtailed. I know of one case in Canada, where all commercial fishing is prohibited in a certain area, even those kinds of commercial fishing which do not touch the stock of sport fish. On the other side, there are more and better-publicized cases, where the anglers feel, and in many cases with justification, that certain stocks of fish are more valuable to the community if used for sport fishing, that is, if used to support the tourist trade and to support all of the service industries associated with sport fishing.

This is a very real problem to the fisheries administrator—to the government, one might say — in its responsibility for making the best use of the natural resources

for the benefit of our people. This responsibility was emphasized at the Federal-Provincial Conference on Fisheries Development called by my Minister in January of last year. At that time, it was not possible to deal with details, but the Conference agreed to call the attention of governments to the importance of sport fishing and to ask that more effort be directed to solving these problems. This action by the Federal-Provincial Conference had something to do with stimulating the calling of this Symposium.

Before I go farther, I would like to give the greetings of the Minister of Fisheries to this gathering. As you know, he was scheduled to take part in the opening of this Symposium. Unfortunately, a house of his in Caraquet, New Brunswick, burned, and this event coupled with the limited opportunity which Ministers, of late, have had to visit their constituencies, persuaded him of the importance of being in Caraquet.

We seem to be rather unfortunate in this Symposium. The main speaker, Dr. Clawson, sent us a wire yesterday saying that, due to a family accident, he was not able to attend. We regret that this is so, and we appreciate Dr. Clawson's kindness in arranging for a very able substitute to attend on his behalf. The principal organizer of this Symposium, Mr. J. B. Rutherford of the Economics Service, is ill and the Director of the Service, Mr. MacKenzie, is unavoidably detained in the Maritime Provinces. Consequently, I hope that you will be tolerant if some of the arrangements seem to go a little bit off the rails. In this connection, I might mention that participants are invited also to bring their wives to the reception being held this evening on behalf of the Minister.

The Symposium, as you know, is organized in this way: there is the main address, prepared by Dr. Clawson, which will be read shortly. After this there will be a brief intermission, which will be followed by the first in a series of panels. Each of these panels will have a separate chairman and separate authors and other members who will participate in discussion actively. It is not our intention that any remarks should be stifled, and we hope that this will be a lively, interesting and valuable Symposium.

Before calling on Dr. Hayes for his remarks and to introduce Dr. Knetsch, who will deliver the main address, I would like to introduce the other two gentlemen at the head table: Mr. Ernest Côté, Deputy Minister of Northern Affairs and National Resources; and Dr. P.A. Larkin, Director of the Fisheries Research Board Station at Nanaimo who, among other things, will serve as Chairman of the first panel.

F.R. Hayes:

It is an honour to be allowed to take part in the opening ceremonies of this important Symposium. In looking over the pre-points of papers to be given, I was struck by the similarity of your problems and those of the biologists interested in population studies. Both have developed algebraic expressions which, one hopes, will describe natural events, but neither possesses many real measurements to put into them. It seems a great deal easier, especially if one has mathematical friends to generate these formulae, which some humorist called models of happenings, than

it is to get any real numbers to place in them; this apparently is correct for economics as well as population biology. The situation reminds me a little bit of the remark of the famous Harvard anthropologist, Professor Hooton, who said the trouble with his subject was that there were more anthropologists than apes. Perhaps this group, as one of its favourable results, may design some simplification in the number-securing process which may lead to advancement.

My economist friends, who are not primarily trained in biology, may not be as well aware as biologists are, that the whole subject of biology is beset with difficulties which are scarcely parallelled in other branches of science, such as chemistry or physics. One of these difficulties which is not relevant to the present Symposium and on which, therefore, I will not expand, is that the framework of theory on which we try to build our subject, namely the theory of evolution, is held by some people to be untrue and by others to be immoral and hence to be restricted to specialists and not to be discussed in the presence of women and children, even though true. This sometimes causes great distortion in the teaching of the subject, particularly in the schools in backward regions of the country as, for example, in Alberta, about which we have been reading recently.

Another difficulty peculiar to biology and relevant to this Symposium is that it has an amateur wing which is not parallelled elsewhere. There are many people doing all kinds of nature study activities, and included among this group of non-professionals who are interested in biology, is a group of sport fishermen. These are people whose equipment, outside of a fishing rod and accessories, consists of a bottle of Scotch or a case of beer and who sometimes come back from their fishing trip with a complete solution to problems with which the economists and biologists have been wrestling professionally without too much success for many years. This is one of the burdens which you have to bear if you happen to be a professional and which you have no doubt encountered in the study of economic values.

I have noticed in some of the Symposium papers, reference to the attempt to examine the interest level of people who go fishing. This is a matter of considerable importance because it is concerned with a phenomenon which is widespread over all our uses of leisure: there are far more things to do with your leisure than available time permits. For instance, a man who returns in the evening, from his day's work, wishing to relax a little, has to make a choice whether to look at TV, turn on the radio, play some gramophone records, or read a book. If he decides to turn on the TV, I gather from these papers that some economists, at any rate, would start charging the cost of heating the house and everything else, as long as the set was turned on, to the cost of national TV operation, and even charge the cost of driving his car back and forth from home. This kind of thing probably occurs sometimes in the evaluations of sport fishing. There is, however, a certain component of the community, in which I include myself, who subscribe to the views of the poet who said.

"What is this life if, full of care,
We have no time to stand and stare,
No time to sit beneath the boughs,
And stare as long as sheep or cows.

A poor life this if, full of care,
We have no time to stand and stare!"

The behaviour of this group might warrant the introduction into any mathematical formulation of the value of sport fishing of a negative term. If this development should commend itself, I would hope that you might honour me by calling it the "Hayes term" because this happens to represent my ideas of the use of leisure time. Many men feel they are under social pressure when preparing for holidays, to take some kind of utensil in order to avoid criticism from their wives and the neighbours. It may be a few golf clubs, a fishing rod, or a gun but what they really want to do is "stand and stare". This is a very real difficulty for, like the fellow who turns on his TV and goes to sleep, a man may just want to relax.

These are all difficult problems which you are going to encounter in your deliberations and they are going to be solved only by a good deal of work over a long term of years.

The first paper in the Symposium is designed to introduce the subject generally and was prepared by Dr. Marion Clawson. Dr. Clawson is not able to be here, for owing to a family accident he was prevented at the last minute from coming, but since he has written the paper, I might mention something about him. After graduating in Agriculture from the University of Nevada, he obtained his Ph.D in Economics at Harvard and has been for over a decade in the service of the United States Government in the field of agricultural economics, and later in the Bureau of Land Management where he served as director. He has published extensively on agricultural development and major irrigation projects and so, I think, could be regarded as a very happy choice to prepare what I suppose would be called in political circles, the key-note speech of this Symposium.

We are fortunate, since Dr. Clawson is not able to be here, in having a colleague of Dr. Clawson, Dr. Jack L. Knetsch, who is a research associate working for Resources for the Future in Washington, who will deliver Dr. Clawson's paper or his own variant of it.

Economic Aspects of Sport Fishing

by

Marion Clawson

Outdoor recreation activity of almost every kind is booming, as everyone at all familiar with recreation knows. Attendance data at parks and other outdoor recreation areas show larger totals each year, at an annual rate of increase close to 10%. Few other economic or social data show comparable rates of growth; electric power generation is increasing approximately as rapidly, air freight movement is growing faster, but few other activities are moving upward so rapidly. The growth of attendance is closely parallel in the United States and in Canada, and in many individual parks in each country. These are exceptions, of course—our Isle Royale National Park in Lake Superior shows no clear upward trend in attendance for many years, for instance.

There is general agreement that the basic factors underlying this rapid and continued increase in park attendance are population changes, growth in real income per capita, improved travel facilities, and increased leisure. More people demand more outdoor recreation. As total population has grown, so has the number of elderly retired or semi-retired people and the number of young people not yet in the labor force—two classes with special demands for outdoor recreation. The proportion of the total population living in cities has also increased; and urban people consume more outdoor recreation than do rural ones. As real incomes per capita rise, a larger percentage of income becomes "discretionary" and more of this is spent for outdoor recreation. With nearly universal ownership of private automobiles and with vastly improved highway systems, travel to more distant recreation spots becomes easier, quicker, and cheaper. Leisure has increased as more people are too young or too old to work, as typical workweeks have been shortened, and as paid vacations have lengthened. The increase in population, in real income per capita, in total travel per capita, and in total leisure in the United States have each been of the general magnitude of 2% annually, compared with the nearly 10% annual increase in outdoor recreation. Some compounding and interaction among these variables seems evident. The situation is generally similar for Canada.

Within the past decade there has been a rising tide of professional interest in outdoor recreation—especially so among the social sciences. Fishery, game, and other biologists have long conducted research and made surveys on various aspects of the natural environment which are important to outdoor recreation. There are many "practitioners" in the outdoor recreation and park management fields in the United States and Canada—men who know a great deal, as a result of their experience. But much of the latter is not written, and some men tend to generalize

more broadly from their personal experience than is warranted. There has been a notable paucity of well-planned, organized research[1]. We economists have just begun to discover outdoor recreation. We have sometimes been critical of the lack of economic analysis, or of the faulty analyses, of outdoor recreation problems; yet in candor we must admit that, until very recently, we have offered very little that was better. In spite of some exciting pioneering studies, there is yet only a limited amount of economic analysis applied to outdoor recreation.

The Whole Outdoor Recreation Experience

In my approach to outdoor recreation, I regard as basic the concept of the whole recreation experience[2]. Almost every outdoor recreation experience includes five rather well-defined phases (Figure 1):

1. *Anticipation, or planning.* This takes place primarily before the family leaves home. It decides then such questions as where to go, when, what equipment to take and to buy, how much money to spend, how long to stay, and the like. As nearly as I can estimate for the United States, more than half of all expenditures for outdoor recreation take place during this phase. Heavy equipment such as autos, boats, motors, camping gear, and the like is mostly bought here. Some people plan their outdoor recreation carefully, on the basis of the best information available; others are haphazard, hasty, or careless, If public agencies want to help people plan their outdoor recreation activities better, to increase their later satisfactions and to reduce their disappointments, I think this is the best stage to do so. Almost no public efforts are directed now to helping recreationists at this stage.

2. *Travel to the site.* Most outdoor recreation requires travel from home to the recreation site. Often, more time and money is spent in this travel phase than is later spent on the site. We lack adequate information but there is reason to believe that for many people this phase is not particularly enjoyable—may even have a negative value. I think it possible that the enjoyability of this phase might be increased considerably.

3. *On site.* This is the phase we most often think of, or talk about, when outdoor recreation is mentioned. Many different activities may take place, with different members of the family often doing different things. This the phase which often gives point and direction to the whole experience, and it is the one by which we often describe the whole. But we should not fall into the error of regarding it as the totality.

4. *Travel back.* The recreationist family obviously must return home; but its route often need not be the same. We suspect that its attitude is significantly different, from the outgoing trip. It may well be that the family responds to different considerations on the two trips.

---

[1] Marion Clawson and Jack L. Knetsch, "Outdoor Recreation Research—Some Concepts and Suggested Areas of Study," RFF Reprint No. 43, November 1963. Reprinted from *Natural Resources Journal,* October 1963. Also appeared in *National Conference on Outdoor Recreation Research,* co-sponsored by School of Natural Resources, University of Michigan, and Bureau of Outdoor Recreation, U.S. Department of the Interior, 1963. (Report distributed by Ann Arbor Publishers, Ann Arbor, Michigan).

[2] Marion Clawson, *Land and Water for Recreation.* Rand McNally, Chicago, 1963.

ANTICIPATION

In anticipation of an outdoor recreation experience, a family plans where it will go and what it will do, and buys equipment and supplies

and this in turn leads to planning for next trip.

RECOLLECTION

Back home again, the family recalls its recreation experience, often with great pleasure. Memories may be an important part of the whole experience

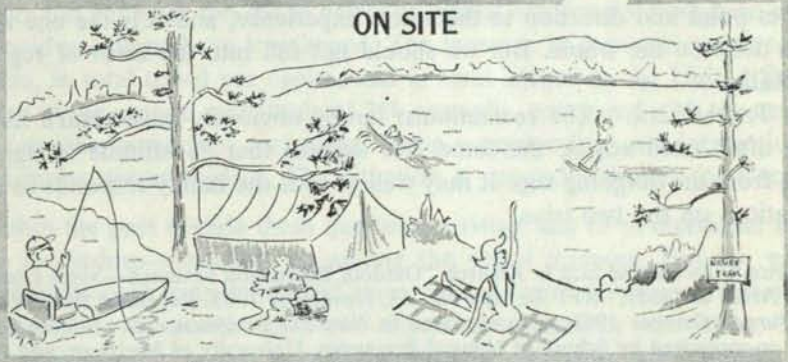
TRAVEL TO

In order to reach the outdoor recreation area of its choice, a family must travel. Considerable expense is involved in such travel, and often as much time is consumed in travel as later on the site. Travel is often not as pleasurable as experience on the site

TRAVEL BACK

When the activities at the site are through, the family must travel back to its home. Often tired, frequently in a hurry, sometimes broke, the family is in a different mood than when it travelled in the opposite direction

ON SITE



When it arrives at the recreation site, the family may engage in many activities. Bodies of water are especially valued for outdoor recreation. The activities at the site generally provide the basic purpose for the whole experience, even when they occupy less than half the time and require less than half the total expense

5. *Recollection.* After the family returns home, it recalls its recreation experience. I have hazarded the judgment that more than half of the total satisfactions of the entire experience arise here. Stories are told to friends, neighbors, work associates, and others; stories often reinforced with slides or artifacts of some kind. The recollection may differ considerably from the activity. Bigger fish are caught, or get away, in the living room or office than on the lake or stream. Experiences unpleasant at the time such as drowning rain, may provide wonderful conversation fodder. The recollection experience gradually leads to planning the next experience, and so the cycle begins again.

We must treat the whole experience as a package deal. Each part is essential to the whole. All the costs of the package must be balanced against all the satisfactions. The annoyance at a dirty restroom en route may offset the pleasure of a new museum in the park, for some people. In research, in economic analysis, in education of recreationists, in tourist promotion, and in park or fisheries administration we must constantly be aware of the whole experience. In my judgment, many park or recreation resource administrators have been excessively preoccupied with the on site phase of the whole experience. They could properly retort that this was their only responsibility, that they were not permitted or required to work off the site of their prime responsibility. But I think we must look at their role in a new light.

Park and Recreation Systems

Another basic concept in outdoor recreation is that of park systems. Different kinds of parks, in differing locations with respect to where people live, of varying sizes, suitable for different kinds of activities, and usually provided by different units of government, form a complex and interrelated system. Although there is a continuum of change along each of these characteristics, it is useful to classify the various kinds of parks and recreation areas into broad groups.

I have used a threefold classification of parks, on essentially economic grounds.[3] User-oriented parks must be close to where people live, for after school or after work use; are often small, and often provided by cities, at least in the United States; involve little or no cash cost in their use, and comparatively little travel; physical requirements for the site are not highly demanding but location is all-important. *Intermediate* parks can be located up to 1 or 2 hours travel time away from users' homes; should be on the best sites available; are typically used for day outings or weekends; individually, must be moderately large; preferably should be suited to a wide range of activities, in order to provide something for each member of the family; and often are state parks or federal reservoirs in the United States. *Resource-based* are characterized by their outstanding physical features; often are located so that relatively long travel is required of most visitors; hence they tend to be used primarily as vacation spots. Individually, such parks are usually very large; in the United States, national parks and some national forests fall in this category.

[3] Marion Clawson, R. Burnell Held, and Charles H. Stoddard, *Land for the Future,* Johns Hopkins Press, Baltimore, 1960.

The Outdoor Recreation Resources Review Commission has proposed a different classification system, based primarily on management criteria[4]. It established six major classes: (1) high-density recreation areas, to be intensively developed and managed for mass use; (2) general outdoor recreation areas, subject to substantial development for a wide variety of specific recreation uses; (3) natural environment areas, suitable for recreation in a natural environment and usually in combination with other uses; (4) unique natural areas, with outstanding scenic splendor, natural wonder, or scientific importance; (5) primitive areas, undisturbed roadless areas, characterized by natural, wild conditions, including "wilderness areas"; and (6) historic and cultural sites of major historic or cultural significance, either local, regional, or national. Although its report does not so state explicitly, presumably the Commission would agree that the lines of distinction between one kind of area and another are not always sharp and clear, and that in fact there exists some degree of continuum.

Although my classification is on economic lines and that of the Commission on management criteria, in practice there is a great deal of commonality between them. That is, a specific park which I would classify as user-oriented would probably be classified by the Commission as high-density; one that I would classify as intermediate, it would probably classify as general outdoor; and so on. Such factors as location with respect to users, size of individual parks, kinds of activities undertaken, unit of government providing the park, amounts of travel required in order to use parks, and the like are not independent but on the contrary are closely interrelated and hence any classification system tends to include all of them, explicitly or implicitly.

However a park system is described and its units classified, there are both competitive and complementary relationships among the various units. If there are two or more rather closely similar parks or recreation areas, each more or less equally accessible to the residents of some city, then the recreation activity of the latter's residents will be divided between the two areas. This is the competitive aspect; one park substitutes for another, and visitation at one is at the expense of visitation at the other. But there may also be a complementary relationship, in that total visitation at the two is greater than it would be at one if the latter were the only one. People like some choice in areas to which they may go. In regions lacking in natural bodies of water, as are our Great Plains and as are parts of your Prairie Provinces, the building of several reservoirs is likely to stimulate greater boat sales than would the building of a single reservoir, even if the latter had adequate capacity to meet the total demand. With various areas to choose among, a man feels it is more worthwhile to buy a boat than if there is but a single area. The same argument may be applied to parks and their typical activities. In many situations, both competitive and complementary relationships exist at the same time.

While these relationships are perhaps most obvious for different parks of the same general type, yet they also exist between parks of different types. If there are

[4] *Outdoor Recreation for America, A Report to the President and to the Congress by the Outdoor Recreation Resources Review Commission,* Government Printing Office, Washington, 1962.

many attractive and conveniently located areas of the intermediate type, many users will feel less inclined to take long trips during their vacations in order to enjoy superior areas of the resource-based type; conversely, if intermediate areas are lacking, poor, or badly located, some people will shift their interest to the resource-based type. These are the competitive relationships. But there may exist also complementary relationships; enjoyment of one kind of area tends to whet the appetite for enjoyment of other kinds of areas. There is some evidence from various studies that the latter is the case.

Although I have illustrated the competitive and complementary relationships in terms of resource-based and intermediate areas, it seems probable that the same relationships exist between user-oriented and intermediate areas, but perhaps less so between user-oriented and resource-based. The competitive and complementary relationships exist among the numerous variants within each major type of area; the closer units are together on the continuum, the closer are probably their interrelations. Although we have speculated about these interrelations, and some evidence exists to illustrate them, yet the whole subject has had most inadequate study.

The system concept as applied to parks and outdoor recreation areas may be likened to an electric power system. In the latter, the various generating plants, transmission lines, and consuming points are linked together in a complex network. Changes in units of generation, or transmission, or consumption, will require changes in the whole system; the way a particular power station is operated depends in considerable part upon the existence of other power plants, and if a new power plant is added, the operations of all the existing ones is likely to be changed also. Or the system concept for parks may be likened to a complex ecosystem in a forest, where trees, shrubs, grasses, other plants, and microbiology of the soil are all involved in a complex interrelation of competitive, symbiotic, and other character. A major part of the environment of each is the presence of the others, and if any major part of the ecosystem is modified materially, this has repercussions throughout the whole system.

Analogies should not be pushed too far, of course, for they then tend to break down. But I think we can safely say that a major part of the considerations affecting the use of any park is the existence of other parks. One cannot estimate the probable use of a proposed new park without considering the existing alternatives; or one cannot estimate the demand for a present park or recreation area without considering the actual alternatives now open to its users; or one cannot manage a given area in the best possible way without considering its place in the whole system, and how its use relates to the use of other areas.

The Role of Sports Fishing in Outdoor Recreation

Up until this point I have been talking about outdoor recreation in general, and now will take up sports fishing in particular. But I think that most of the general points about outdoor recreation apply also to sports fishing. To anticipate a little the following more detailed discussion: I think we can state that fishing often provides the focus or the *raison d'être* for the outdoor recreation experience as a whole, and thus has unusual importance.

Perhaps we can best start by considering why people fish, or what classes of fishermen there are. I know of no careful study of the subject, but let me advance a few ideas based largely on my personal experiences. There are relatively few fishermen whom I would call purists, or devotees, or connoisseurs. They are highly informed, not only about their sport but about the fish, the fishing areas, the methods of fishing, and the like. They are willing, and usually able, to incur relatively large expenditures for that kind of fishing in which they are most interested; and often they travel far for it. I would judge that at least some of your Atlantic Coast salmon fishermen fall into this class, as well as others for other kinds of fishing.

There is another, and I believe much larger, class of fishermen whom I would call the active sportsmen. They are interested in fishing, but not obsessed by it; able and skillful at fishing, but not purists about it; willing to spend money and to travel for good fishing, and moderately well-informed about it, but probably balancing expenditures for this purpose against alternative uses of the same money.

Finally, there is the very large group of people who fish largely as an incident to being out-of-doors, either for themselves or for their children. I have been impressed, as I visit various kinds of recreation areas in the United States, to see how many of the visitors do some fishing, but often in a most casual and uninformed way. They often lack tackle, or at least appropriate tackle; often do not know how to go about fishing in the particular area where they are—or perhaps in any area; often have little or no "luck" and may take inordinate pride in trophies that more skilled fishermen would scorn; and seem often to be dominated by the desire of their children to fish, rather than by any real desire on their own part. Perhaps you do not have this class of fisherman in Canada; possibly I have exaggerated a little, but I think you could find many families that would fall in this category at many public and private areas in the United States. It would be easy for skilled fishermen to be scornful of these "fishermen"; but we probably should take note of their interest and should recall that they are usually taxpayers and voters, and that their attitudes toward fishing may go far toward determining the financial support for public fishery programs.

What is the role of fish in fishing? I note that this conference is on sports fishing, not on sports fisheries, and I suspect that its subject was wisely, and probably consciously, so chosen. One might even ask: are fish necessary for fishing? Relatively few genuine sports fishermen value their catch primarily as food. Salmon perhaps have greater value here than some other kinds of fish, in part because they can be canned or smoked readily. But many fishermen are embarrassed at their fish, because they will not eat them. We are getting increasing amounts of "fishing for fun" in the United States, in which the trout or other fish is released immediately upon being caught. Many fishermen value their fish as trophies. This need not be limited to large fish; a boy or his father may value an 8-inch trout for this purpose, as well as 200-pound marlin. But the fish is a perishable trophy, unless one is willing to spend some money having it skinned and mounted. I understand that in much of the sailfish, marlin, and other ocean sports fishing off the Florida coast, there has grown up a procedure under which the fish is quickly hung up and

weighed, the fish and fisherman photographed together, a certificate signed by the boat captain, and the fish at once released unharmed to swim away for another day.

Far more than food or trophy, fishing is probably valued as an experience—the joy of being outdoors, the thrill of a strike, the excitement of landing, and even the sharp disappointment at losses. For some fishermen, the beer is as important as the bait, when they are stocking up to go. This kind of fishing is very much primarily a recreation experience, to be judged in terms of other recreation experiences.

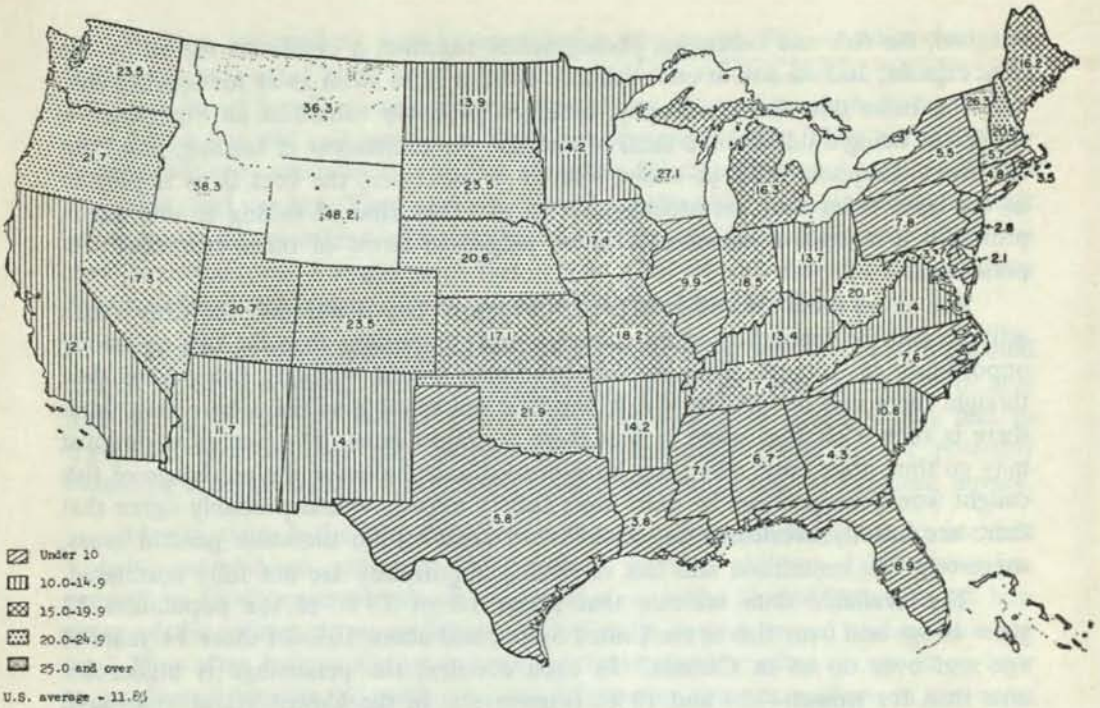
For all of these and other kinds of fishing, it is possible that the fisherman's attitude and the reputation of the area are more important than the fact of fishing opportunity or success. That is, few fishermen would willingly fish where they thought there was no chance of catching fish; but many may fish where they think there is such a chance, when in fact there is almost none. The perennial optimist may go time after time, when any hard-headed calculation of the poundage of fish caught would suggest that he quit. Most fishery experts would probably agree that there are heavily overfished and underfished areas within the same general areas, suggesting that reputation and fact of fishing opportunity are not fully correlated.

The available data indicate that about 18 or 19% of the population 12 years of age and over fish in the United States, and about 10% of those 14 years of age and over do so in Canada.[5] In each country, the percentage is higher for men than for women—29 and 10%, respectively, in the United States, compared with 18 and 3%, respectively, in Canada. In each country, the percentage participating is relatively high in the young adult age years of 25 to 44; but in the United States it is highest in the years from 12 to 15 and nearly as high from 16 to 17, while in Canada these latter are years of less than average participation. In the United States, participating in fishing seems to rise modestly with income, at least up to moderately high incomes. Fishing license sales in the United States have risen rather rapidly and steadily for as many years as we have reasonably dependable data, suggesting that total participation in fishing has risen during the same years.

Various estimates are available as to regional differences in participation in fishing in the United States. On a broad regional basis, the national surveys of hunting and fishing show a low rate of participation in the Northeastern regions; about average in the East North Central, South Atlantic, and Pacific regions; and above average in the West North Central, East South Central, West South Central, and Mountain regions[6]. The extreme difference between regions is from slightly less than 10% of persons 12 years of age and over participating in fishing, up to over 28% participation. Sales of fishing licenses in 1950 show a somewhat different pattern by states (Figure 2). Although most of the Northeast is still low, there are some exceptions; but now most of the South is low. Perhaps most interesting is the

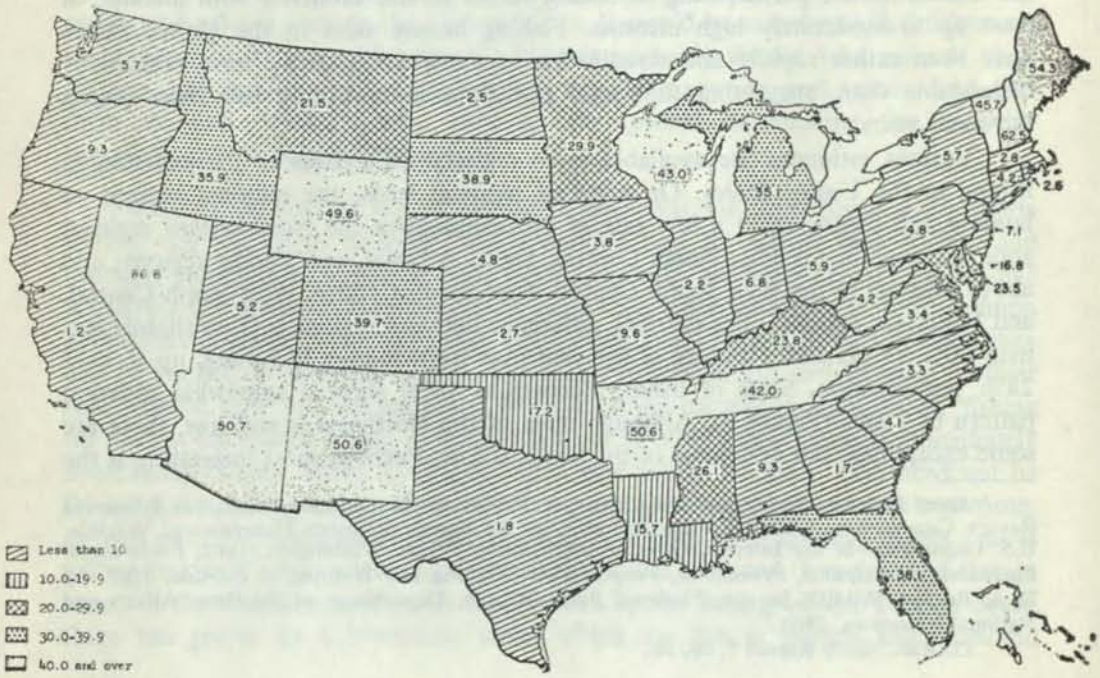
[5] *Sport Fishing—Today and Tomorrow.* A Report to the Outdoor Recreation Resources Review Commission—ORRRC Study Report 7, by the Bureau of Sports Fisheries and Wildlife, U.S. Department of the Interior, Government Printing Office, Washington, 1962; *Preferences, Purchases, Participants, Prevalence, People, You—Fishing and Hunting in Canada, 1961, by* D. A. Benson, Wildlife Service, National Parks Branch, Department of Northern Affairs and National Resources, 1963.

[6] ORRRC Study Report 7, *op. cit.*



Above, percentage of population 15 years of age and older, possessing resident fishing licenses—1950.

Below, nonresident fishing licenses as percentage of resident fishing licenses—1955.



situation in the northern Rocky Mountain States, where over 35% of persons 15 years of age and over seem to have bought fishing licenses. One cannot be entirely sure of these ratios, because some people may have bought resident licenses who were not residents of the states in the usual sense of the term. The most extreme was Wyoming, where almost half of the people bought resident licenses; it is noteworthy that almost half as many nonresident licenses were also sold in this state.

These data seem to indicate that, where fishing opportunity is reasonably good and close, a substantial proportion of the total population will spend money, if they can afford it, for fishing. I hesitate to say what the potential market is for fishing, among any population of given age, sex, income, and other characteristics; but I do feel confident in saying that the potential number of customers is higher than present actual numbers in most parts of the United States and Canada. If we experience the future trends in total outdoor recreation that I think will occur, then sports fishing is going to experience a major further increase in demand—especially if you fisheries people are able to continue to supply reasonably good fishing opportunity.

In view of the present large public participation in fishing in many areas, and the probable further increases in numbers of people who will seek to go fishing, it seems to me that fisheries specialists must be as concerned to manage people as to manage fish. The value of sports fish depends on what people are willing to pay for the fishing experience, as I shall discuss below, rather than upon the value of the fish *per se*. Their attitude toward the experience of fishing, of which the fish is only a part, and sometimes only a small part, will determine their willingness to have public funds expended for fisheries improvement. Perhaps we must plan to educate, guide, and maybe even wet-nurse novice fishermen to a much greater degree than we do today. This may all seem a far cry from fisheries research and management, but I think it is what the public is going to expect.

Demand, Expenditures, and Income on Sports Fishing

Data on expenditures made by fishermen are often collected, yet their value is by no means clear. It is difficult to collect such data and they are often of dubious reliability because of memory bias and other reasons. One major question is: which items of expenditure to include? More specifically, shall outlays for new equipment be included, which often makes the expenses for a particular trip or year seem very high? or shall costs of new equipment be excluded, with or without some form of depreciation or other charge for use of equipment bought in prior years? In spite of their deficiencies and uncertainties, data on fishermen expenditures do have a certain interest and do give some idea of how much people are willing to spend for this kind of outdoor recreation, and for which specific items.

But I suggest that studies of fishermen expenditures are, or might be, much more useful. Perhaps unconsciously, a study of gross expenditures does employ the idea of the whole recreation experience. We ask a man how much he has spent on the whole trip, travel and all, of which fishing was the main purpose or focal point.

Presumably, each man spends up to the limit of his willingness to spend, or his ability to do so, for the whole experience, balancing up its satisfactions to him against its total costs, or against alternative uses of the same money, and coming back again or staying as long as total satisfactions balanced total costs. With comparatively limited exceptions, his fishing costs do not include a payment for the fishing privilege as such. I realize that charges are paid in the form of club memberships or otherwise for certain kinds of fishing, especially for salmon along the Atlantic Coast. But most fishing on the North American continent is without much or any charge for the fishing as such. Many fishermen would have paid for the privilege, if they had been forced to do so.

The total expenditures incurred by the fisherman thus do not, as a general rule, include the value of the fishing opportunity as such. They are the cost of the total fishing experience, as incurred, and including only such charges as the man actually paid. While his costs may be considerable, yet it can well be said that they are for the purpose of enjoying the whole experience, and do not directly or simply reflect the value of the fishing opportunity as such. Yet, in the words of one of my state park director friends, "the value of the recreation is concealed somewhere in those attendance figures". By working from the expenditures for the whole experience, and introducing hypothetical charges of different amounts, and noting their effect upon attendance, one can indeed calculate the value of the fishing opportunity. Mr. Spargo is familiar with this and other techniques, and I presume that he will discuss them tomorrow, so I shall not go into more detail at this point.

I should like instead to pose a few hypotheses as to the factors affecting the number of recreation visitors or fishermen visiting any given area:

1. The number is directly and proportionately variable with the number of persons resident in each zone of origin. Put another way, visits per capita or per 1,000 resident population are constant regardless of the size of the population in the zone of origin. This does not preclude variations due to differences in income or other characteristics of the resident population, but does rule out variations due to the size of the resident population alone.

2. The number of visitors from each zone of origin is inversely, but not necessarily proportionately, related to the cost of getting from the zone of origin to the recreation site. For this purpose, costs may be measured in dollars, in time, or in distance—sometimes one measure will be better, sometimes another, and often all three will be closely correlated. The inverse relationship may indeed be proportional, or proportional to the square, the square root, of some other function of cost or distance.

3. The number of visitors from each zone of origin is directly, but not necessarily proportionately, related to their average income, to their available leisure, and to the travel facilities between their homes and the recreation site. It seems often to be related to other socio-economic factors, such as education, occupation, race, age, and others.

4. The number of visitors to any one site is related, mostly inversely, to the number, location, and attractiveness of alternative sites for the same kind of activity

—in our case, for fishing. If there are many good quality alternatives, conveniently located, then visitation to a particular site will be less than if alternatives to it are few or poor or both.

One could build a simple mathematical model based on two assumptions: that number of visitors is inversely proportional to the distance from their homes, and directly proportional to the resident population in each zone of origin; and this model might explain or account for most of the differences in visitation between different sites. One could construct a model of a system of parks or recreation areas, based upon these two relationships, and the effect of a new park in the system could be calculated. There is, I think, a fertile field for inquiry and study here, with the real possibility of useful models for research and management purposes.

A few words may well be said about the recipients of the expenditures made by fishermen. Their expenses are income for someone. Who the recipients are, and where they are located, depends in part upon the items of expenditure included in the study. As we have noted, most of the equipment is purchased in the home town of the recreationist. For short trips, he buys his gasoline and groceries here also. For longer trips, he must spend more money en route or at the site of his recreation. But even for the longest trips, the expenditures at or near the site may be a small part of the total. While fishermen or other recreationists from relatively distant parts do bring some additional money into the local recreation area, yet more of the business they generate is likely to be in their home towns. The makers of automobiles, cameras, film, motorboats, motors, and much other equipment owe much to the national parks and other prime vacation areas, for instance. It is this disparity between place of expenditure and place of recreation which makes it difficult for local units of government to provide recreation opportunity at a profit to themselves and their citizens. In the United States, this is part of the rationale for federal grants in aid to states and from states to cities and other units of local government; in this way, the burden of supplying recreation opportunity is more widely spread, and perhaps rests more equitably on those benefiting from it.

Some of the expenditures made in a local area pay wages or profits to local people, but a large part goes to buy supplies or raw materials imported into the local area. When a fisherman buys a tank of gasoline, some part of his expenditure pays the wages of the service station attendant as well as other local costs. But much is used to import the gasoline from a more distant refinery. The same is true of other items of expenditure. On the other hand, the local recipient of these expenditures in turn buys other goods and services, some part of which is provided locally and some is imported. The relative proportions supplied locally and imported vary considerably depending in part upon the nature of the local economy but also upon the size of the area under consideration - how big is "local"? For the typical vacation type recreation area, it seems probable that less than half of the direct expenditure by recreationists is for locally provided goods and services and that more than half is for "imported" goods; but consideration of the second, third, and possibly later rounds of expenditures generated by this initial outlay may raise the local propotion substantially.

Conclusion

All the signs presently available seem clearly to point to a much greater demand for sports fishing in the future. Perhaps it will be less discriminating as well as a larger demand. The period of "mass fishing" may well be upon us soon. The problems of fisheries people will increasingly shift from fish to people—how to educate, help, guide, and hopefully satisfy the recreationists seeking some fishing. This will inevitably impose new and different burdens upon researchers and managers alike. Whether one welcomes these imminent changes or views them with sorrow, the problems will be more easily dealt with if foreseen and met as they arise.

Participants at opening of Symposium.

I — ECONOMIC ASPECTS OF SPORT FISHING

Panel 1 (a) — The Basis for an Economic Approach

(Held jointly with members of the Fisheries Research Board of Canada, January 5, 1965, 3:15 p.m.—5:00 p.m.)

PANEL MEMBERS

Chairman

P. A. LARKIN,
Director, Biological Station,
Fisheries Research Board of Canada,
Nanaimo, B.C.

Author of Background Paper

ANTHONY D. SCOTT,
Department of Economics,
University of British Columbia,
Vancouver, B.C.

Other Members

C. H. CLAY,
Department of Fisheries of Canada,
Vancouver, B.C.

H. SCOTT GORDON,
Department of Economics,
Carleton University,
Ottawa, Ont.

JOHN DAWSON,
Economic Council of Canada,
Ottawa, Ont.

SOL SINCLAIR,
Head, Department of Agricultural Economics,
University of Manitoba,
Winnipeg, Man.

Panel 1A, "The Basis for an Economic Approach." Left to right, Sol Sinclair, P. A. Larkin, Anthony D. Scott, H. Scott Gordon, C. H. Clay, John Dawson.

The Valuation of Game Resources: Some Theoretical Aspects*

by

Anthony Scott

Part I—Introduction

The purpose of this paper is to examine some of the theory lying behind a common method of valuing recreational resources, which depends on the travel costs incurred by visitors coming from various distances, and the frequency of visits from those distances. It assumes that a fee (called hereafter a "toll") raised to a certain level would evoke from nearby visitors a changed frequency of visits similar to that observable among remote visitors whose travel costs are already at that level. Thus an optimum toll might be found, which, capitalized, can be called with some justice the value of the resource to the visitors.

This method is examined, but no alternative is suggested. It is remarked, however, that it can be corrected for its neglect of the opportunity cost of travel, if researchers will take the trouble of examining the occupations and incomes of visitors. It is then shown that the demand for visits depends circularly on the quality of the resource, which, for fish and game resources, in turn depends upon the number of visitors. It is suggested that in the absence of a huge number of questionnaires, this problem for valuation can only be resolved by the actual imposition of a toll. The same conclusion emerges from an examination of the problem for evaluation of the existence of alternative game areas that are free.

In the final part, the paper digresses to ask why tolls are not or cannot be levied. It is shown that the frequent use of high fees for "foreign" visitors already implies some governmental acceptance of the toll idea, for a free resource fully used has no local value unless the users are local people. It is concluded that, for fish and game resources at least, the best way out of the valuation problem is actually to impose a toll.

This is no idle conclusion. Recreation resources, appropriately managed, can be expensive of labour, capital and alternative uses of land. Governments are properly reluctant to allocate funds to their maintenance and retention against eager industrial land users. Thus to find those sites that should properly be neglected and those that can earn a real income in recreational uses higher than in any competing use it is essential to make valuations. But, whatever may be the situation in multiple-use parks, picnic grounds and recreational areas, some of which have the

* An earlier version of this paper was presented to the Agricultural Economics Workshop at the University of Chicago. I am grateful for suggestions from Professors T. W. Schultz and Eugene Smolensky. This draft is still preliminary, however, as will become apparent.

"neighborhood" effects described by Milton Friedman[8] the estimating of hunting and fishing values by indirect methods seems a wasteful approximation to the direct route of actual pricing.

Part II—Valuation of the Resources

(*a*) *Assumptions*

1. It is initially assumed that valuation means the capitalization of the maximum annual net return from the hunting or fishing use of the resources, without discrimination among visitors. This assumption is referred to briefly in section (e) below.
2. Current maintenance costs are zero. This assumption is relaxed in section (g), on resource quality. In effect, the valuation is the capitalization of a toll, or fee, for admission.
3. The unit of demand is the visit. This unit is later modified to the visitor-day (hunter-day, "rod-day").
4. Visitors come from concentric zones.
5. Travel brings no pleasure in itself. This assumption is taken up in sections (c.2) and (f).
6. Zones differ in distance and population [see however the conclusion to section (d)] but not in incomes and tastes.

(b) *Finding the demand curve for visits.*

The data are assumed to be gathered from a questionnaire filled in completely and helpfully by all visitors. See the table in section (d).

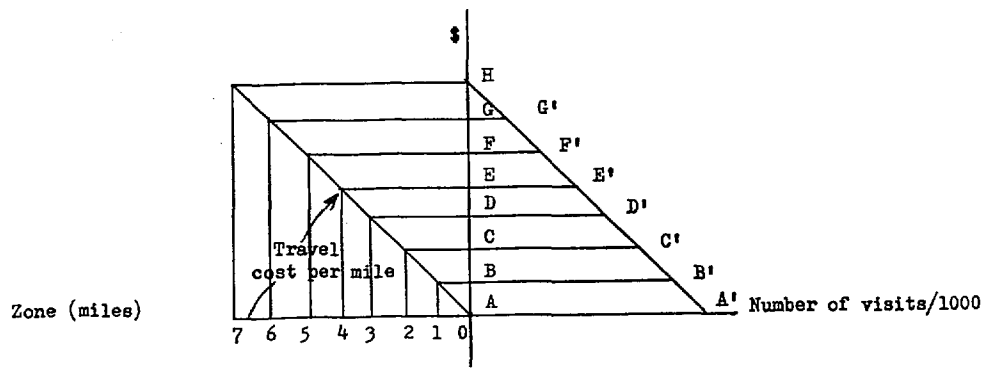


Diagram 1

When the number of visitors per thousand of population from each zone is plotted against the travel costs from each zone, a curve like A′H is traced. Assume that it is linear. Hotelling[4] suggested that this curve be treated as the demand curve for visitors from Zone O, because it shows the number of visitors willing to pay each cost. Thus if Zone O people had to pay a toll equal to the travel costs actually incurred by visitors from Zone 2 (AC), their visits per 1,000 would fall from AA′ to CC′.

This hypothesis implies various prior assumptions, especially that incomes and tastes among zones are identical. A slightly weaker assumption about incomes and tastes is required if the curve is supposed to be helpful only for increases in costs or tolls: incomes and tastes of *visitors* are identical.

The effect on the demand curve of the opportunity cost of time is postponed to section (c.3).

The demand curve for people from, say, Zone 4 is similarly derived. It is the same curve, running from H to E′—the base of the quadrant is in effect moved up from AA′ to EE′. This means that for any given increase in travel cost or toll the elasticity of demand will rise as we move to farther zones, even if the derived curve is not linear. In the diagram, it is assumed that travel costs are constant per mile; in fact the steady slope of the travel-cost curve is likely to be interrupted by steps caused by the buying of food and shelter every 3 or 5 hundred miles.

From these zonal demand curves, and knowledge of the zone populations, a demand curve for visits to the resource can be built up. It can also be expressed algebraically. The following symbols are used. It is initially assumed that all relations are linear.

- h: time in travel in hours per mile.
- k: opportunity cost of travel in dollars per hour
- M_i: distance of Zone i from the site.
- N_i: population of Zone i. $\Sigma N_i = N$
- m: "cash" travel cost in dollars per mile.
- v_i: visits to the site per 1000 from Zone i.
- V_i: visits to the site from Zone i. $N_i v_i = V_i . \Sigma V_i = V$.
- t: toll or fee at site per visit.
- p: total cost per visit.

To find the effect of a toll on attendance, we assume that we have data on all the variables and constants given in the above list. Then the demand curve for any zone must be of the form

$$v = \alpha - \beta p \qquad (1)$$

Expanding p for the costs it actually represents, we obtain, for a given zone:

$$v = \alpha - \beta (k\,h\,M + m\,M + t),$$

$$\text{or} \quad v = \alpha - \beta\,k\,h\,M - \beta\,m\,M - \beta\,t. \qquad (2)$$

This expresses the Hotelling hypothesis for any zone: a change in t has the same effect on v as that observed when we examine the visits of people with successively higher travel costs.

The aggregate demand curve for visits to the site from the population of all zones in terms of changes in t is then

$$V = \Sigma v_i N_i = N\alpha - \beta\,h\,k\,\Sigma N_i M_i - \beta\,m\,\Sigma N_i M_i - N\,\beta\,t. \qquad (3)$$

The early literature, noting that all items in the first three terms were constants, in effect assumed that a regression curve fitted to visits against travel costs could be identified with the above equation, and that its slope was a measure of β. But this is incorrect [3,5].

The visitors from any zone asked to pay a higher toll *will* now be in a cash position similar to that of visitors from a more remote zone; but their opportunity cost of time in travel will not change. Consequently they would make more visits at this cash cost than the remote visitors did. This suggests that the measured β is absolutely too large. We seek a corrected parameter b to substitute in equation (3). The nature of the correction is simple. In Diagram 2, the base is drawn for (say) Zone 2. It is proposed to raise the toll by the amount of the excess of Zone 3 cash travel costs over Zone 2 costs.

To find the reduction in Zone 2 visits, consider the extra cost DA, and the decrease in visits DE. We have estimated β from DE/AD.

Actually, however, Zone 3's extra costs are not only AD but also CA opportunity costs. Thus C must be a point on the "true" demand curve; and a toll of AD will cause a Zone 2 visit decline of only EH.

To find b, the slope of CE, note that $DE = bCD = \beta AD$. Hence

$$b = \beta \, AD/CD \qquad (4)$$

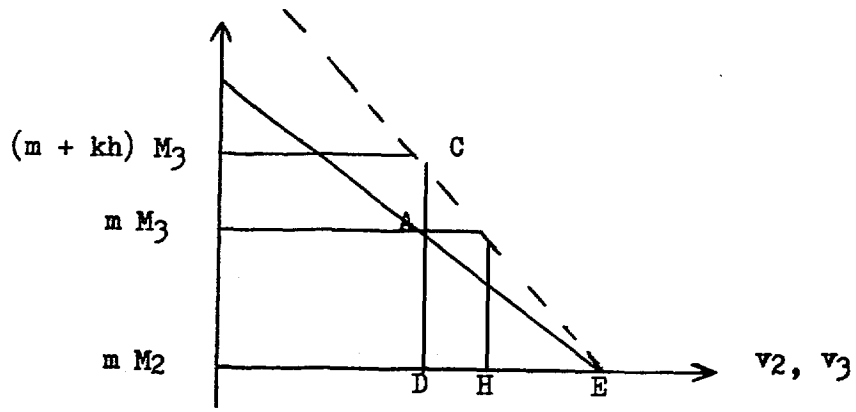


Diagram 2

Thus we can estimate b in terms of the observed β. AD/CD is equal to the ratio of "cash" travel costs of Zone 2 visitors to their total costs, or

$$b = \beta \frac{m M_i}{m M_i + h k M_i} = \beta \frac{m}{m + h k} ,$$

which is the same for all zones if m, h, and k are constants.

The corrected aggregate demand curve may now be written

$$V = \Sigma v_i \; N_i = N\alpha - b(k h + m) \; \Sigma N_i M_i - N b t$$

$$\text{or} \quad = N\alpha - \beta m \Sigma N_i M_i - Nbt \qquad (5)$$

where α is approximated by the observed number of visits from Zone O and b is the empirically-derived β as adjusted by equation (4).

It is submitted that equation (5) can be identified with a curve fitted according to Hotelling's suggestion. However, the assumptions about the constancy of parameters and about the availability of data suggests that a review of them would be helpful.

(*c*) *Qualifications and hypotheses about the demand for visits*

The terms on the right hand side of equation (5) may be taken in turn.

1. *Population, N and N_i.* There is less difficulty in obtaining zonal populations than any of the other items. For example, zones may be equated with census areas.

However, the farther the zone from the site, the smaller is v_i the number of visitors per 1,000 of population. For example, if the remotest zone, which might produce a considerable number of visitors, were simply the "rest of the world", v would be an absurdly small fraction, subject to extreme random variation. In section (d) it is proposed that zones be set up of approximately equal population.

Such variability in an outer zone is unlikely to seriously affect the empirical measurement of β or b. But because N does enter into the aggregate demand curve as part of its slope, some other approach may be preferable.

Trice and Wood [11], for example, have proposed merely arraying travel costs of all visitors, without regard to the distance travelled. They then cut off the extremely high travel costs by assuming that the 90th percentile is in effect the top corner of their "demand curve."

The difficulty with this and similar cutoff procedures is that, in throwing away information it produces a demand curve that is not very useful for predicting what would happen if travel costs (or tolls) did rise to the level paid by those from the remotest zones. It also makes it difficult to predict outer-zone visits if travel costs should fall after the construction of a new route. On the whole therefore it seems advisable not to dismiss visitors from remote areas from the demand curve by some cutoff technique.

What we observe is that there are a very few visitors from remote places like New York City to every site whose demand is studied. If a few come, why not many? Income is clearly not a sufficient explanation: a better candidate is alternative opportunities at lower travel cost. But that any come at all indicates that the assumption of uniform tastes (say, among people of equal incomes who visit some recreation area of this type) is likely to prove treacherous. Clawson's writings[2] on this subject indicate the diversity of motives and circumstances of visits.

2. *The elasticity of demand with respect to cash costs.* This can be estimated from b. In our equation, it has been assumed that the response to a unit change in cash travel costs and to a change in toll is identical. Opportunity costs are dealt with below.

It is obvious that travel does not simply impose a cost. Clawson in particular, stressing that the whole recreation experience from anticipation to reminiscence must be taken into account, reminds us that people often enjoy the trip as much as the goal—the latter may indeed be negligible, or disappointing compared to the former. Conversely, the trip may be disastrously tedious and tiring. This obser-

vation may turn out to be more important for planners responsible for the creation of new recreation areas and parks (and systems of parks) than for those concerned with the valuation of existing sites. See section (f) below.

Fortunately for our approach, it seems likely that fishermen and hunters are less enthusiastic about the long trips they endure than are family groups making summer trips to the same area. This hypothesis might be tested in certain areas frequented by hunters or fishermen in the autumn and winter and by holidaying families during the summer. It suggests that the relative frequency of summer visitors from a given remote zone would be greater than of winter visitors. For those coming from successively more remote zones, demand with respect to travel costs would be less elastic than of winter visitors. Unfortunately, however, there could be many explanations of the results of the test of this hypothesis, for the summer experience is different from goals of hunters and fishermen.

We are left with the looser hypothesis that travel cost demand curves will prove better predictors for hunters and fishermen than for holidaying families. A test of this hypothesis depends on once-for-all changes in travel costs (or tolls) and may be possible in areas about to offer improved access to both groups. Unfortunately again, the information that access had improved often also informs people, for the first time, that the resource exists. Thus a before-and-after test depends on samples drawn from different universes, and is open to several interpretations.

To conclude, it obviously is not certain that the elasticity of demand with respect to travel costs provides an estimate of the elasticity with respect to a toll. That it does can only be tested by putting on a toll.

3. *Opportunity costs of time.* It was clearly presumptuous to assert that the opportunity cost of time, k, is constant for visitors from all regions and is measurable. Worse, the analysis has so far neglected the opportunity cost of time spent at the resource. We now discuss the modification of these three assumptions.

Consider first the absolute value of k. Becker[1] and Mincer[6] have suggested that it is a positive function of wage income for income—and consumption—opportunities foregone.

Because hunters and fishermen are a relatively small part of the population, we may take their wages, incomes and hours of work as given, in each of the occupations that are now examined. We are looking for testable hypotheses about the visits of persons with differing incomes and occupations.

(i) Farm workers and other rural people, especially in the autumn, have much spare time during the day. Hence the income opportunity cost of *hours* spent visiting the resource will be low or zero. But because they are needed daily on their farms or ranches, they will find it expensive in income-hours to stay away overnight. Because their cash income is low, they will have negligible opportunity costs of consumption-hours. Hence we may expect frequent, short visits from local farmers, but many fewer visits from those farmers who must spend a day or more travelling, even if their cash travel costs were the same. It is just possible that

selected items drawn from questionnaires would serve to test this hypothesis: that hours of travel rather than travel costs give a better prediction of visits for farm people.

(ii) Wage earners will seldom be able to afford visits during their work week. Hence, most of their visits will be on days off or weekends, when their income-opportunity cost will be close to zero. The higher their wage rate the larger the number of their recreational alternatives, and the higher their consumption opportunity costs. Hence, from a zone with zero cash travel costs, we would expect that visits will decline with wage income. But this effect will be swamped, in more remote zones, by the income constraint on cash travel costs, and the expectation can be tested only in the closest zone.

(iii) Salaried workers are not paid by the hour, but because they are expected to put in a full work-week their visits should be essentially like wage-earners'. Also, the higher their income, the greater the consumption opportunity cost.
Both hourly-rated and salaried workers should therefore make visits longer than a weekend only in their annual holidays.

(iv) High-income persons will be able to "buy" more visits, although the opportunity-cost of income and consumption also both rise with income. Thus we would expect that the average level of visitors' incomes would rise with their zone's distance from the resource. But the number of miles travelled will rise less than income.

(v) Professionals frequently have more command over their time than managers and executives. Although the income and consumption opportunity cost will probably be the same for all groups with a given high income on the average over the year, the professional man may be able to arrange longer holidays, within which he will regard both his income and leisure opportunity costs as negligible. Thus we would expect, within a certain income group, that professional and self-employed workers will make longer trips and longer visits. Put another way, from remote zones the visits of professional people should exceed their proportion of the zone's population of given income.

(vi) Finally, for persons with a relatively larger independent ("unearned") income, the opportunity cost of income may be zero. If questionnaires could identify such persons, it would be possible, by comparing their behavior with those of persons with equal total incomes, to estimate the effect of income opportunity costs.

To summarize thus far, we would expect that among observed visitors, those from nearby zones will be dominated by people of low income, making short visits, while as the distance travel increases, observed incomes will rise and the proportion of self-employed, professional and independent-income receivers will rise.

This presumably means that the observed opportunity cost of time rises with distance, and is not constant as is assumed in section (2) above. In common-sense terms, a toll will have almost no effect on the visits of those for whom the opportunity cost of travel in consumption or income terms is the chief constraint. It will affect chiefly Zone O and Zone 1 visitors.

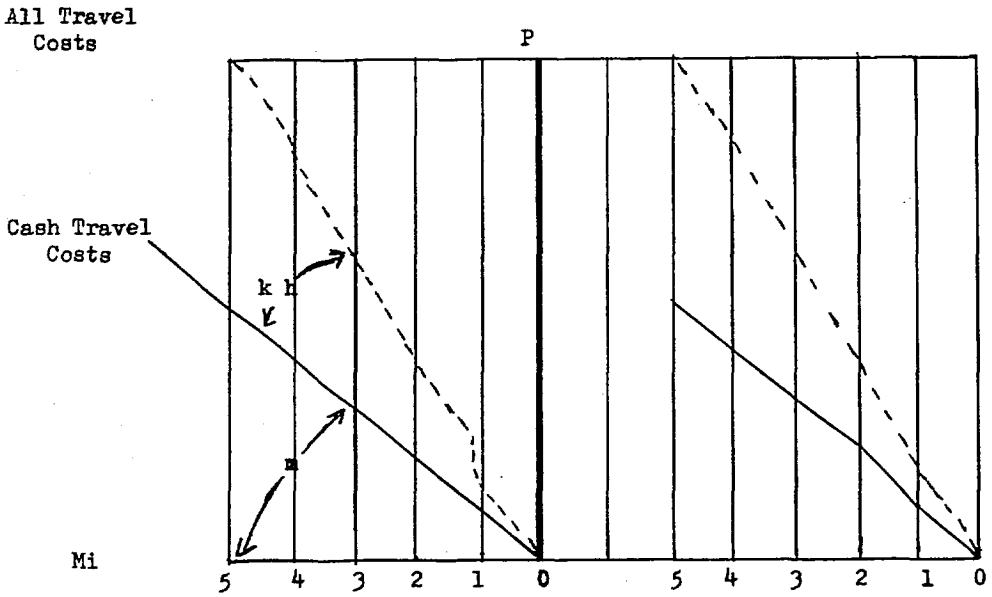


Diagram 3

In the right-hand quadrant of Diagram 3, the solid curve again shows the observed visits as a function of cash travel costs, and the dashed line is the "corrected" curve based on all travel costs. They are respectively derived from the curves of m, and of $(m + h\,k)$, in the left-hand quadrant. The latter curve has been given a shape corresponding to some of the considerations mentioned above. From O to 1 kh is very small, and so β provides a fair estimate of b. But beyond Zone 1, the travelling distance is great enough that many visitors of the same income and occupational groups as in Zone 1 cannot "afford the time"; kh jumps, yielding in the right-hand quadrant a true demand curve appreciably more inelastic than the empirically-derived curve. Beyond the jump (which is at a distance where only one work day is lost if the resource is visited) the true demand curve becomes increasingly inelastic with respect to tolls compared to the observed curve.

The opportunity cost of travel has been given as hk. The observed inelasticity of the "true" curve therefore also depends on h, the number of travel hours per mile. This parameter is of course a long-run variable that is partly under the control of the resource planners. New access roads and air routes will reduce h. Making it possible for people to live near the site will reduce their h to zero (and raise local rents).

This suggests a final correction to the travel-derived demand curve. Because visitors from remote regions have more money than time, their cash travel cost curve may become steeper $\frac{dm}{dM_i} > O$, but their opportunity costs per mile may fall $\frac{dh}{dM_i} < O$. This means that for remote visitors, or high tolls, the observed and "corrected" demand curves will be closer together than in the absence of alternative, clearer and faster means of access.

(d) *The length of a visit.*

This model does not so far allow for the fact that the observed length of the visit varies systematically: those who come the farthest stay the longest. For example, 145 respondents to Mr. Spargo's [10] questionnaires produced the following:

Table 1

Area (1)	Respondents (2)	Trips (3)	Fishing Days (4)	Average Total Cost Per Respondent (5)	Trip (6)	Fishing Day (7)	Fishing Days per Trip (8)	Days per Respondent (9)
1	11	296	296	$ 57	$ 2	$ 2	1	27
2	68	622	1,283	160	18	8	2.0	19
3	6	39	88	203	31	14	2.2	15
4	18	45	205	140	56	12	4.5	11
5	2	2	11	183	183	33	5.5	6
6	6	6	30	173	174	34	5.0	5
7	34	35	470	458	445	33	13.4	14
All	145	1,085	2,383	223	30	14	2.2	17

The small number of respondents (visitors) from Areas 5 and 6 does not provide reliable information. Area 7 is "all the United States", and clearly should have been subdivided. A "day" is a day spent fishing, not travelling; no information is provided directly on the average time spent travelling from the various zones, the method of travel, or even the average distance travelled.

We know, however, that the time used in travelling increases as we go down the table, so that the total opportunity cost per trip must also increase roughly as the average cost per trip (column 6). This suggests that the temptation to substitute one long visit for several short visits must increase with distance, as indeed is to be observed in column (7). So obvious is this relation that many studies make visitor-days, and not visits, the dependent variable in producing a demand curve of the type examined above. To be able to do so is valuable not only for the valuation of the resource, but also as we shall see for managing its quality.

The substitution of long visits for numerous visits should be most attractive to those with higher opportunity costs, that is, with higher incomes. Unfortunately, this hypothesis founders on the double influence of income; while those with high incomes may be expected to attempt to save on travel time by visiting longer, they

might also be expected to visit frequently and briefly by expensive, high-speed means such as chartered aircraft. Thus the effect of income on length of visit must be studied within a group confined to those who come by identical means from a given distance; the resultant sample may be too small for useful conclusions.

While no attempt will be made to summarize the details of sections (c) and (d), one conclusion can be emphasized. If the purpose of the demand inquiry is to discover the number of visitor-days to be expected at given tolls, it follows that information on opportunity costs is essential to avoid under-estimating the elasticity of demand. With the above model, some intelligent guesses about the influence of these costs could be obtained from information about visitor's incomes and occupations. It is suggested that the rather restricted clientele of hunting and fishing resources, and the deep interest of this clientele in problems of "conservation", should ease the problem of obtaining income information. In any case, it should be sought.

A lesser conclusion concerns the problem of zonal populations. It will be noted that all terms in the aggregate demand equation contain a population variable. When zones are designated on arbitrary principles (provinces or states, census districts, electoral ridings, or countries), they may differ fantastically in the size of the population of which the zonal group of visitors is supposed to be a sample. Study of the equations suggests that while there is something to be gained by distinguishing zones so that their centres are equidistant, there is much more to be gained from making them of approximately equal populations. The tapering-off and income-selection effects of distance can much more easily be studied in this way. This point is suggested by the uninformative aggregation within Zone 7 in Spargo's table.

(e) *Pricing and valuation*

The purpose of finding the demand curve was to find the "value" of the resource in the recreational use at a given level and distribution of GNP, a given concept of "value", a given structure of substitute recreation resources, and a given quality of the resource. These matters may be dealt with in turn.

The first matter for discussion is the assumption that the general level and distribution of GNP are given. If the GNP per head increased, there would be both an income effect and a substitution effect on resource demand as suggested in earlier pages. If the distribution, expecially the regional distribution, of the GNP altered, the present relationship of distance and income would be upset and the demand curve for visits would change. Finally, a change in the regional distribution of population would also affect the number of visitors. But these aggregates may be taken as given by resource planners. With the conspicuous exception of the population and income of the zones immediately adjacent to the resource, the use and price of the resource will have little effect on the nationwide income aggregates that might affect demand.

The second matter is the meaning of "value". It is often stressed that an asset's value depends upon the purpose for which the valuation is required. A high value may be "correct", but irrelevant.

We seek a valuation that can be used in efficient decision-making about the use of land and the level of management and maintenance expenditures. Land-use decisions depend on the rents from alternative uses, discounted to a common date. The alterna-

tives to recreational uses are usually agricultural, though other industries, such as mining and logging, may also be important. Because the rents that are paid or could be paid by these industries are determined in more-or-less competitive factor and product markets, where monopoly is usually temporary and effective discrimination is difficult, a good approximation to the rent they can offer for a piece of land is the capitalized value of their revenues net of all costs (including a minimum profit) on the assumption that a single price is charged for each type of product they sell.

Similarly, it may be convincingly argued that the cost of inputs for management and maintenance depends upon factor prices determined in predominantly competitive, one-price markets.

It follows that a valuation which is to justify a recreational use of a piece of land, inputs for management and maintenance, must also be a simulation of a "competitive" rent. The valuer must not assume that the hypothetical sale of recreational services discriminates between customers: all must be assumed to pay the same price per visitor-day. The concept we seek, therefore, is not the *area* under the demand curve for visits, which would imply discrimination, but the largest profit rectangle that can be inscribed, which would imply a single price.

This means that we must reject the valuations actually obtained by Trice and Wood, Spargo and other followers of Hotelling. If demand curves were linear, we should instead accept about one-half their valuations, or less. Following Clawson, and particularly Brown and Castle [1a and 1b] instead, we should capitalize what is commonly called the "monopolistic" revenue. (This means, incidentally, that if total management costs are not variable with respect to the number of visitors, that we seek a toll where the demand curve, net of the constant management costs, has unit elasticity. This may be fairly easy to identify.) The word "monopolist" is of course a misnomer, because the hypothetical owner would be in competition with the owners of other recreational sites. What should be stressed is that he would be a sole owner, charging a single price.

As in all benefit-cost decision criteria, the rate of interest used in capitalization should reflect the best alternatives available for the use of capital.

The Trice-Wood method is actually a short-cut, avoiding the working out of a full demand curve. Its disadvantages are not only that it searches for the irrelevant consumer's surplus, but also that it is highly sensitive to essentially arbitrary decisions made by the researcher. As Crutchfield[3] in his survey of techniques has pointed out the measure [(break-even travel cost)—(median travel cost) x (number of visitor-days)] is correlated with the choice of break-even travel cost. Only with a very large sample would it give values similar to those obtained by a grouped Hotelling approach, except by accident.

Two other short-cuts may be mentioned here. One involves asking visitors what their benefits have been, or what they would demand to stay away. "Ask a hypothetical question and you get a hypothetical answer"; the results of this procedure have yielded some extremely fanciful valuations. Worse, they show some respondents' inevitable misunderstanding of the question, for many valuations are close to their actually-incurred expenses. These are like the U.S. National Parks' valuing recreation at what

it costs to supply it ! A more promising method is to emulate a private promoter's attempt to get visitors to commit themselves contractually to future payment for a planned future service; but even this practice, which often is used by new sports and game clubs, is unsuccessful in finding all the members who sign up when the facilities materialize.

A final short-cut is to value the fish or game resource at its "meat" value. For many sportsmen, this value is a trifling part of their benefit from the area, and is rightly deprecated. But like the travel-saving measure mentioned immediately below, it does help to establish a minimum valuation. For local people, especially, (and for those spending several days visiting) the fish or game taken may be consumed and bring about a saving of food cost. The capitalized value of this saving is worth estimating, but surely falls far short of the valuation sought.

All short-cuts tend to neglect the population apart from the visitors sampled. One virtue of the demand-curve procedure, carried out in full, is that it makes it possible to examine the steadily-falling number of visitors *per thousand* as zones become more remote. If discontinuities are seen, they may be investigated. In this way, a better demand curve of *potential* visitors at each cash cost can be built up, possibly by interpolating over random fluctuations and discontinuities.

The third and fourth matters, the competition of alternative areas, and the influence of quality, must be dealt with in separate sections.

(f) *Alternative game areas.*

Most tolls are now close to zero, hunting or fishing licenses rarely being specific to an area. The demand function so far developed suggests that levying specific toll would cause nearby visitors to emulate remote non-visitors, who avoid travel expenses by going elsewhere. Clearly, however, they will do so only if they have an alternative of similar quality and cost. This must be investigated. The elasticity of the demand curve adjusted for substitutes will differ from the estimate according to the number of substitutes. If, as is often the case, Zone O visitors have a number of alternatives only slightly inferior to the chosen area, they will abandon that area which is now priced, and its estimated demand curve will be far too inelastic. If, on the other hand, they have no local alternatives, they will visit more frequently than remote visitors did at that total cost; the estimated demand curve is too elastic.

A visitor's attitude to an area and its substitute depends both on their quality and their location. The fact that remote visitors pass by some substitute areas suggests that, to them at least, their quality is inferior (although curiosity, and a taste for variety, are other explanations). Spargo's questionnaire found, for example, that the next-best alternative was for many visitors one they had passed en route.

In the field of recreation research, this finding should be regarded as very strong evidence. It implies that the attempt, by Spargo and others, to impute to a site a value that is in effect a locational rent is inadequate. (The theory was that the existence of the resource in Zone O saved the people of the first few zones the cost of travelling to farther zones. Their saving was estimated, and after adjustments, imputed to the resource.) This procedure gives at best a minimum valuation. However, it also suggests

that while the evaluation of a recreational resource by the travel-cost-demand method must contain a term for at least one alternative, the travel cost saved or lost at an alternative site is by itself a treacherous indicator. Ideally, what is required instead is a function which takes into account the prices of substitutes. It is difficult to see how information on this matter could be obtained, except by direct question: "Would you (how often would you) visit this site if its toll were $ x per day and that at Y River were $ z per day? A questionnaire with the values of x, Y, and z varying from respondent to respondent, might throw some light on the cross-elasticities involved.

But, once again, such hypothetical questions produce hypothetical, careless and extreme answers. A better approximation might be obtained by observing behavior when alternative sites are closed. The best results, of course, would be obtained by experiments with actual tolls, each announced as permanent.

These considerations also suggest that new recreational areas cannot be planned in isolation. Better valuations and recreational programs would be obtained if all close substitutes were valued simultaneously.

Neither a new game area nor a system of areas can be planned in isolation. A public area, planned on the basis of benefit-cost analyses[10] will make its best contribution to the recreation system and to real national income, when its valuation contains terms for users' alternatives. Similarly, a private owner can decide how much to pay for land and inputs only when he knows the extent to which his charges or tolls will divert visitors to alternatives. Nor can either assume that alternatives are free, for two reasons. First, public valuations, based on hypothetical tolls, will obviously be too low unless it is assumed that alternative sites charge the same amount for similar quality. Additionally the political hypothesis that the government imposes a toll on one area surely requires similar assumptions for other government areas.

Second, the imposition of a toll on some areas will create a market for others, both private and public. It is hard to predict the decisions of Public Lands departments, but presumably they will not, in the long run, be greatly different from those of private land owners. These are represented by a supply-of-recreational-land function. The second reason for inserting an alternative price into the demand function is that the elasticity of supply of alternatives may be very great. Some American experience with recreational loans to farmers, which have been eagerly taken up, confirms this belief.

This elasticity depends on the value of alternative uses of the alternative sites, now largely private. Consider fishing. In a formal sense, streams and lakes are not used for purposes that compete with fisheries; rather, the conditions of these other uses are usually open to modifications that will allow fishing as well. Water may have to be impounded, allowed to settle, purified, channelled or stocked with fish. Visitors may have to be given access. These are all matters of expense, in labour and capital, but rarely do they displace the existing users. The hypothesis that the elasticity of supply of fishing sites is high amounts to a belief that (with the conspicuous exception of migratory fish), the expenses involved may not be great. Probably the overcoming of water pollution, a subject that is now almost an independent discipline, is the most complicated and expensive. But if tolls for fishing were actually charged, many of these problems might miraculously disappear: industrial and

domestic water users are glad to purify their wastes if they profit by doing so. It is not necessary of course, that *all* waters become fisheries when the toll rises slightly: elasticity is a relative number. All that is suggested here is that the number of fishing streams and lakes would increase greatly.

It is more difficult to generalise about hunting sites. To the extent these depend upon migratory wildfowl, the problem is difficult to settle through the price and property markets, and an effort similar to that of Ducks Unlimited is required, fortified by regulations and international treaties. But for grouse and pheasants, and even for big game, supply elasticities similar to fishing may apply. Certainly the United States has seen a great expansion of the alternative hunting sites, now that hunters have become willing to pay more than the license fee (which is often motivated by the control of firearms rather than by the management of supply of game).

Thus, research is necessary. It is suggested here that the supply of alternative sites is elastic with respect to tolls and charges. If research or experience bear this out, the true values of today's remote sites may be considerably lower than the capitalization of the hypothetical maximum toll of a site taken in isolation presently suggests.

(g) *The influence of quality on value.*

Finally, we turn to the final assumption, that the quality of the resource is given, though it may differ from the quality of its alternatives.

This assumption is usually made, probably, because of the divided jurisdiction between economists and recreational administrators—the former worry about tolls and values, while the latter manage the resources. The point of view of the latter (usually ecologists, biologists, foresters or soils specialists) is barely economic. While their concerns range widely from the preservation of scarce scenery and game to the presentation of as much "nature" as possible to as large a public as possible, their interest in economics is merely that it provides an administrative or budgetary justification of land acquisition, retention and improvement. It is far from their professional approach to think of recreational sites as competing with each other for consumer expenditure and time, farther still to consider that quality is a characteristic measurable by visits and not by scientific criteria, and farthest to think of product quality as a manipulatable variable. This criticism, if it is one, applies chiefly to those concerned with so-called unique natural areas and "wilderness areas", not to those concerned with playgrounds, parks, picnic and roadside camping grounds. On balance, we may be thankful that government has recruited so many talented and dedicated experts for recreational management, and urge them to pursue their efforts to maintain both quantity and quality.

But this praise does not mean that the best economic outcome would result from the combination of naturalists' maintaining quality while economists estimate the appropriate tolls. For the naturalists' problem is dominated by the interference in nature of a large number of people, which number (be it for camping, hiking, hunting or fishing) is influenced by the toll. Any price rations use. On the other hand, the price that visitors are willing to pay depends upon the quality the site offers. Thus the market theory of the product as a variable, like price and quantity, must be invoked.

We cannot explore all the implications of this conclusion. But several observations may be made with particular relevance to hunting and fishing.

1. Biologists must be urged to pursue their game population studies in order to discover the state of the resource under various levels of visitor-pressure. Both economists and biologists are apt to forget that the dependent variable should be sustained annual game yield, not the size of the game population. It is true that the latter is an important determinant of hunter—or fisherman—success so that, *ceteris paribus,* enjoyment and value increase with the density of the population. Thus a large sustained yield (= rate of natural increase) from a very small population might be so sparse on the ground that animals or fish are never seen. But this should not be assumed to be the case. In general it is wasteful of land and maintenance expenditures (such as winter feeding, restocking, etc.) to attempt to maintain a maximum population rather than, say, a maximum sustained yield.

2. Furthermore, biologists must be reminded that a *maximum* sustained yield is only a proximate goal. If, at a given level of hunter success, and so of demand at a certain price, some levels of sustained yield are cheaper than others, they should be sought. A physical maximum is rarely an economic goal.

3. Economic studies must seek the demand at each level of fishing—or hunter-success. On the plausible assumption that dedicated hunters and fishermen care little about scenery or location, visits at each average level may be predicted by comparing them to visits to neighbouring areas with different levels. The aim is to find jointly the optimising levels of hunter-success and toll.

4. But the pursuit of the optimum leads to a valuation that is based on two unrealised assumptions: that a maximizing toll *is* levied and that the resource *is* managed at the optimum level relative to this toll. Is it correct to value resources that will remain both free to public access and uneconomically managed, on these falsified assumptions?

Crutchfield has argued in the affirmative in a related problem[3]. Dealing with commercial fisheries in their competition with alternative water-resource users, he has argued that the notorious absence of net returns arising from the common-property fishery should be disregarded. In comparisons of use valuations, the fishery should be assumed to be efficiently managed, as if by a franchised sole-owner without monopoly powers. Thus many units of commercial fishing effort would be assumed to be eliminated, and modern methods assumed to be introduced, so that approximately the same catch would be taken at a much lower cost (ten percent in one case studied). The resultant "potential" valuation should be used, according to Crutchfield, in commercial resource-use comparisons.

This argument runs counter to most applications of welfare economics. Even in the context of land use, it is rarely argued that low-rent industries should be allotted high-value urban land simply because a desirable reorganization of that industry "could" prove to be the highest-paying occupant. Only if the land allocation is irreversible (as it may be in urbanization or dam-building, but rarely is in competition with agriculture) can extra weight be given to the "potential" argument. It puts the cart before the horse: efficiency of organization should precede land allotment. An un-

reformed, inefficient "industry" on land with high alternative values will simply waste the land's alternative product.

5. Leaving aside other recreational uses (summer camping, mountain-climbing, swimming, boating) that are an end in themselves, attention must however be given to the fact that wildlife resources have a "state" value as well as a "use" value. People are willing to pay for the existence of public goods for private reasons. Thus British nature enthusiasts have contributed to the setting-up of game reserves in Africa, all the world offered to contribute to the maintenance of a captive killer-whale in Vancouver, and most Americans approve public expenditures on "wilderness" areas that they do not wish to visit personally. How such reserves should be valued is baffling in the absence of spontaneous private contributions. This is the basic problem of the public finance of public goods. But it should not be asserted that unvisited resources are valueless.

6. A related observation is that many fishermen and hunters do not actually reduce the stock. As Clawson has remarked, some hunters take animals' photographs, and some fishermen return their catch to the waters. More generally, many people are indifferent to their success, either valuing the "whole experience" or taking pleasure from seeing animals rather than taking them. As Hall [3a] has pointed out, the resources enjoyed by such people must be managed in such a way as to eliminate the encroachment of all industrial uses, and to *maximise* the stock of game. Providing enjoyment for people with these tastes is obviously a very expensive business.

7. For most game resources, however, many uses are compatible. If pollution and so on are controlled, agriculture and fishing can easily co-exist. Game and farming are more directly rivals, for game and cattle like the same lowland ranges and meadows. In general there is a concave-inward transformation curve between alternative uses, measured in numbers of animals yielded, displaying diminishing returns. (This curve is being investigated by my colleague Professor Pearse for the Rocky Mountain Trench game resource, and has been used schematically by Hall).[3a] The curvature of this transformation curve suggests that it will be tangent to a social indifference curve at some combination of both uses. (However, for "wilderness" enthusiasts, as described in 6, joint use is anathema.)

This combination of uses, such as wildlife with farming, mining, forestry, summer camps, highways and even housing makes the job of valuing a "game resource" much more difficult. It turns out that what is being valued is some level of the game yield, some semi-civilized environment, some joint-use access routes, and some attitude of the local citizenry to hunters and fishermen. Hunting or fishing is a joint product. But it may be suggested that valuation is all the more desirable. When the frontier encroaches on the wilderness it is essential to know what recreational values are being destroyed, and when their value at the margin is sufficient to "buy off" further encroachment, to justify the substitution of intensive management outlays for acreage, or indeed to buy out existing users in favour of extending the recreational area.

(h) *Recapitulation.*

It may be useful, at this stage, to recapitulate the suggested modifications of the travel-cost-derived valuation. We begin, following Hotelling and Clawson with the

function *vi,* which on the assumption of linearity, gives us βN, the slope M of the aggregate demand curve. The resultant single-price valuation would be *lower* than Hotelling's because it disregards consumers' surplus in excess of the price. It would have to be *raised,* however, to allow for the effect on the fitted β of the opportunity costs of time. Next, it would have to be *lowered,* perhaps considerably, to allow for the existence of substitutes, their toll, and the elasticity of their supply. Next, it might have to be *raised* if charging a toll would indirectly raise the quality of the resource and move the demand curve outwards. But because this improvement would also take place on other sites, the demand curve for one site would be *lowered.*

Thus the optimum toll, the amount to be capitalized for valuation purposes, depends upon many variables. Because tolls ration attendance, raise the demand for substitutes, and provide the means for management outlays, these aspects all imply that decision-making about the resource's quality must proceed simultaneously with decision-making about the optimum toll.

Part III—The Pricing of Resource Uses

In Part II it was shown that a value for the resource could be obtained, mechanically, by estimating the maximum present value of net returns that could be gained by the imposition of a hypothetical toll. With respect to the difficulties of estimation, it was argued that the actual imposition of a price is unlikely to change the distribution or size of the GNP, so that costs and incomes could be taken as given. On the other hand it was shown that because valuation depends upon the assumed level of quality and the availability of substitutes, and the charges put on both of these, little confidence could be put on estimates of area valuation unless prices were actually imposed.

The question may well be asked then, why not actually impose charges? Although this is a policy and not a measurement question, it will be shown at the end to be germane to the problem of evaluation.

It is clear that the chief reason why tolls are not levied is that free hunting and fishing on public lands has been regarded as a "right" for centuries in North America. It is not far-fetched to argue that one reason for migrating in this continent was the desire to escape the restrictions of the old lands, including, for rural people, the savage laws protecting feudal-derived hunting, forests and fishing rights, Thus new arrivals and their descendants have valued highly the free game rights on this continent, as part of their freedom; any suggestion of a toll on game areas meets strong opposition especially from poor rural people.

Apart from this historical background, one can think of other reasons for opposing a general policy of tolls, private ownership, or both. One of these is that the collection cost may exceed the revenue. This can easily be true for those fishing areas that have many means of access, and may also be true of those large mountainous big-game areas that support relatively small herds. But this argument does not convince. There are many game areas with only one access route; serious sportsmen are usually conscientious about paying fees and getting licenses; and, when the toll is high, those who have paid tolls actually give assistance in the detection of "poachers."

In any case, it does not follow that a collection-cost in excess of revenue collected must be avoided. It may be that the loss of consumers' surplus, caused by over use of a game area (producing danger of hunting accidents, congestion or merely low hunter-success) in the absence of the optimum toll would exceed the toll's cost collection. Then some variety of Pigovian welfare economics, taking a favourable view of the redistribution involved in someone else's paying the toll-gate maintenance expenses, would conclude that the toll should be imposed, and the gate supported "somehow". The marginal-cost pricing literature would suggest three sources. First, a lump sum could be paid by the visitors in addition to their toll. This is quite practical for game areas, because a state-wide or province-wide license fee is usually levied already (treated above as part of travel expense) and because most visitors use more than one area during the license-fee period. The subsidy for toll collection would then be minimized, involving a small income transfer from those who visit frequently to those who do not. A lump-sum tax would be approximated, and Pareto conditions approached. Second, the toll could discriminate among visitors. Many formulae suggest themselves, from charging less for a season ticket than for a single visit, to "soaking the rich" from outside the province or state. Most practical formulae, because they involve a widely-varying marginal toll are hard to defend on equitable grounds unless there is a community consensus that (for example) cheap hunting or fishing is a sensible way of redistributing income toward those in deprived backwoods areas. Third, the toll-collection could be subsidized from the public purse. Again, this seems justifiable only on the grounds that the income redistribution involved is "good".

Another reason for having no toll could be that the service supplied by any area differs among visitors, so that some should be charged by the scenic day, others by the fish caught, others by the animals shot, and still others for the congestion cost they impose on more proficient sportsmen. Unless tolls are differentiated in this way, the full use of the area will not be realized; or, more probably, certain uses will be excessive for the full enjoyment of the rest. This does not convince. It is not difficult to differentiate tolls according to the use that is being made, or to the time of year. Indeed, some fishing and hunting license systems already do this, in a rough-and-ready fashion.

It would seem then that, history and custom aside, continued free access to game areas can be justified only if, as emerges above, the redistribution in favour of sportsmen is a social "good", or if the resource assumes some characteristics of a public good, valued according to some social preference functions.

That free hunting and fishing do redistribute income cannot be denied. Usually the taxpayer must make a tax contribution to maintain the stocks and access routes, and an opportunity contribution in the loss of the land for other uses and of tax, chiefly property tax, revenues. While it could be argued that catering to the vote-powerful rural hunters and fishermen, and to the lobby-powerful urban fish and game clubs is a valid exercise of the government's redistributive powers, it is unlikely to satisfy economists. Indeed it may be argued additionally that because rural people do value free game, they remain in low-productivity employments longer than if there were a toll, thus imposing both a cash cost (in assistance) and an opportunity

cost (in growth of GNP) on society as a whole. One would think therefore that careful questioning would show that society has little to gain from a general subsidy to hunting and fishing. And the care of state legislatures to avoid game conservation expenditures that exceed revenues from licenses reinforces this conclusion.

The last possible defense of free access to game is that it provides some social good. The usual categories here turn out to be pretty weak. The "welfare of future generations", for example, whatever its merit as an argument in other contexts, clearly is invariant with respect to the price levied for a publicly-owned resource, and if the usual economic argument about conservation of natural resources has any validity, is also invalid for a privately-owned area. Perhaps, though, it could be argued that society jointly obtains pleasure from the *existence* of National Parks and wilderness areas? Observe, for example, the indignation encountered by Friedman's proposal for the sale of the National Parks and, to a lesser extent, the widespread support for the U.S. Forest Service's "wilderness reservations". Because it is difficult to mobilize voluntary support for this kind of reservation for reasons explained by Samuelson and others[9] perhaps game areas should come into the category of "public good". The problem created by this answer is that game areas, although they provide recreation similar to that privately enjoyed in National Parks and Wilderness areas, are not states of nature that non-sportsmen enjoy. Few people would be willing to say that the increase in the number of fish to be caught in a lake from 100 to 200 is in any sense a public good, a benefit not only to the fishermen, but to city dwellers who never stir off the highway. It is important not to confuse game resources with game reservations; only the latter could be reasonably called a true public good. (This non-collective nature of hunting should be distinguished from Weisbrod's suggestion that people may be willing to pay an insurance premium for the "option" of eventually visiting a recreation area.)[12]

All this line of argument suggests that, apart from the real difficulties and costs of collection and enforcement, there is little to be said for free access to game resources. Each should have its own toll. It should be observed that, although a toll will have a rationing effect on use, regulation within the area will probably still be necessary. A sport situation, no less than an open range, a commercial fishery, or an oil well, is still a common-property resource. But a toll will reduce the number of regulations that are necessary for wildife management.

This question suggests two points that are immediately germane to the valuation question. The researcher usually must ask whose point of view he is to adopt in making an evaluation. By adopting the toll-capitalization strategy he is implicity assuming the search for a market valuation in national, indeed international, terms. But as he proceeds he often finds he is expected to give special weight to purchases from local business for guides, accommodation, supplies, etc. Items that he has regarded as a cost of travel, etc., are partly considered, by local people, as benefits from the resource. In benefit-cost analysis this is called using the "regional point of view" as opposed to the national. It is easy enough to incorporate an adjustment for this attitude, if necessary. But it leads him to wonder what is the correct point of view. The legal positions vary from region to region, but the prevalence of state or pro-

vincial hunting licenses suggests that in some sense the resource is owned by the state (or province) so that maximizing from its point of view is correct.

This brings us to the second point. When he examines state and provincial behaviour, he finds that out-of-state visitors, and foreigners, are usually welcomed, and discriminated against. Their licenses and tags are more expensive, their open seasons are sometimes shorter, and they are often obliged to hire guides. This is presumably because, in the absence of tolls, the state does not receive real benefit from the resource unless foreigners are forced to pay cash.

But this practice, although sloppily inefficient, is not the researcher's problem. His difficulty is that, in valuing a free resource by the hypothetical-toll method, he is really trying to find how much domestic visitors have gained, to balance against the domestic costs of retaining and maintaining the resource. The costs can be ascertained, but the gains, to hunters, have to be estimated. Thus he is forced to *subtract* from his hypothetical revenue the amount that would be paid by foreigners! The result of all this is that resources managers must scramble to show that superb recreational areas, little used by local people, are worth retaining. Their problem is a real one, for so long as there is no toll it seems absurd for regional governments to maintain the areas for the benefit of foreigners.

To be brief, the only route to efficiency for this kind of problem is actually to levy a toll. Hypothetical valuations must assume the local point of view, and, so long as they are hypothetical, there is little or no local value. Taken in combination with the "quality" conclusions of Part II, this suggests that valuations are of little use unless tolls are actually levied. And the brief policy digression in this part suggests, that for game resources as distinguished from other types of park and wildlife reservations, there is no valid economic argument for keeping access free.

BIBLIOGRAPHY

1. BECKER, GARY S., *On the Economics of Time,* Unpublished manuscript, Dec. 1963.

1a. Brown, Wm. G., Singh, Ajmer, and Castle, Emery N., *An Economic Evaluation of the Oregon Salmon and Steelhead Sport Fishery,* Technical Bulletin 78, Agricultural Experiment Station, Oregon State University, Corvallis, 1964.

1b. Brown, Wm. G., and Castle, Emery N., *Economic Value of a Recreational Resource,* Western Agricultural Economics Research Council, Committee on Water Resources, *Proceedings,* No. 13, Washington State University (forthcoming).

2. CLAWSON, MARION, *Methods of Measuring the Demand for and Value of Outdoor Recreation,* RFF Reprint 10, Washington, 1959.

3. CRUTCHFIELD, JAMES A., *Valuation of Fishery Resources,* Land Economics 38, May 1962, 145-54.

3a. HALL, GEORGE R., *Product Quality and Public Land Management,* Land Economics, 40, Feb. 1964, 59-66.

4. HOTELLING, HAROLD, in R. A. PREWITT, ed., Economics of Public Recreation, National Park Service, Washington, 1949.

5. KNETSCH, JACK L., *Outdoor Recreation Demands and Benefits,* Land Economics, 39, Nov. 1963, 386-96.

6. MINCER, JACOB, *Market Prices, Opportunity Costs, and Income Effects,* in Carl Christ, ed., Measurement in Economics, Stanford, 1963, 67-82.

8. FRIEDMAN, MILTON, *Capitalism and Freedom,* Chicago, 1962, 31.

9. SAMUELSON, PAUL L., *Pure Theory of Public Expenditure,* R. E. & S. 36, Nov. 1954, 386-9.

10. SPARGO, R. A., *Evaluation of Sport Fisheries: An Experiment in Methods,* Unpublished manuscript, Economics Service, Dept. of Fisheries of Canada, Ottawa, June 1964.

11. TRICE, A. N., and WOOD, S. E., *Measurement of Recreation Benefits,* Lands Economics, 34, Aug. 1958, 195-217.

12. WEISBROD, BURTON A., *Collective Consumption Services of Individual-Consumption Goods,* Quarterly Journal of Economics, 78, Aug. 1964. 471-7.

Summary of Discussion

Panel 1 (a) : The Basis for an Economic Approach.

Following a presentation of a résumé of the "Valuation of Game Resources: Some Theoretical Aspects," the chairman asked the panel members for their comments.

The discussion which ensued revolved around the need for an evaluation of sport fishing, the difficulties inherent in such evaluation as well as the methods that could be used.

A general consensus evolved on a definite need for evaluating sport fishing for policy decisions especially where there are conflicts in the use of the resource, where there is a need to consider appropriate levels of investment in sport fishing facilities as well as the consideration of alternative uses of such investment in competing recreational facilities such as museums, historic sites, etc.

The difficulties which confront any attempt at the evaluation of sport fishing were considered to be neither unique nor specific to sport fishing but to be shared with other industries such as broadcasting and roadbuilding where there is a lack of a pricing mechanism by which to measure demand. Initial attempts at land appraisal over 30 years ago met similar difficulties. The lack of attention to this problem by economists was deemed to be largely responsible for the little progess made in this direction.

The imposition of a toll as a method of evaluating sport fishing engaged the panelists and participants for the greater part of the discussion. Efforts at evaluation involve finding a hypothetical or actual demand curve and demand, strictly speaking, is only meaningful in terms of price. Because there is a lack of a market situation in sport fishing where price is determined, it was suggested that a toll offered a simple and direct solution to the establishment of values.

The advantages and disadvantages of tolls were discussed. Some of the advantages of tolls were cited as the possible levelling off of peak periods in the utilization of the resource and the assurance that once the appropriate toll is imposed a proper exploitation of the resource ensues.

Objections were raised to the use of tolls solely as a means of testing public reaction. Another objection consisted in the inability of a toll on one specific site to be considered in isolation from other fishing sites or other recreational facilities. It also raises the question of income redistribution. It was further pointed out that the imposition of a toll on readily-accessible facilities defeats its purpose in that it discourages the use of the facilities by the people for whom they were intended. An exception to this last objection was cited as in the case of inaccessible resources used by the wealthy.

It was noted that the objections to tolls rested upon the assumption that recreational facilities should be free. However, it was suggested that the evaluation of recreational facilities cannot be considered free unless the value of these assets in alternative use has been determined as zero.

The experience with the use of hypothetical tolls in the United States was cited. Administratively-determined values are used arbitrarily to establish a range for the evaluation of the benefits that result from fishery improvements proposed with multipurpose water developments. The imputed value of the benefits fall within this range and its actual level depends upon the quality of the resource. These benefit values are used in benefit-cost analysis when considering additional or improved facilities.

Alternative methods of evaluation were briefly discussed. These methods included (a) the calculation of savings by users of recreational facilities at site A compared with the use by these same users at site B, (b) interview in depth to determine the subjective value to the users of recreational facilities and (c) interviews with the users of a given site to determine the price needed to induce them to forego, once they are at the site, the experience of the pleasure derived from the recreational facilities.

Panel 1 (b) — Methods and Techniques of Evaluation

(January 6, 1965, 9:00 a.m.—10:30 a.m.)

PANEL MEMBERS

Chairman

E. P. WEEKS,
Executive Director,
Atlantic Development Board,
Ottawa, Ont.

Author of Background Paper

R. A. SPARGO,
Economics Service,
Department of Fisheries of Canada,
Ottawa, Ont.

Other Members

K. R. ALLEN,
Biological Station,
Fisheries Research Board of Canada,
Nanaimo, B.C.

D. A. BENSON,
Canadian Wildlife Service,
Ottawa, Ont.

DAVE YOUNG,
Senior Economist,
Department of Mines and Resources,
Winnipeg, Man.

JACK L. KNETSCH,
Resources for the Future,
Washington, D.C.

N. H. MORSE,
Head, Department of Economics,
Acadia University, Wolfville, N.S.

Panel 1B, "Methods and Techniques of Evaluation" Left to right, David H. Young, D. A. Benson, R. A. Spargo, K. R. Allen, E. P. Weeks, Jack L. Knetsch, N. H. Morse.

Methods and Techniques of Evaluation of Sport Fishing

by

R. A. Spargo

This paper was originally intended to be a presentation of the methods and techniques which are available for evaluating benefits from outdoor recreation—with specific reference to sport fishing. However, even considering this matter at the technical level, it became evident that the forces at play, misunderstandings and confusion in approach have been inhibiting factors in the application of economic concepts and principles to recreation development, and have been perhaps of more consequence than the adequacy of methods and techniques at our disposal.

It was felt that the presentation of the methods and techniques should be made within an examination of a wider conceptual framework. As the broad examination of this framework is to be made in other papers prepared for the symposium, only those facets which bear more directly on the mechanics of economic evaluation will be considered here. These will be followed by the presentation of methods and techniques together with some personal conclusions.

Part I—Some Preliminary Considerations

Types of Economic Investigation

Broadly speaking, economic investigations may be either of two types (a) "Aggregate Analysis" or (b) "Project Evaluation". Both are "economic" in the sense that they are concerned with goods and services but they are fundamentally different conceptually, and in their usefulness to deal with particular problems.

(a) *Aggregate Analysis*—Aggregate analysis is essentially descriptive. The idea of a "Tableau Economique" developed quite early in the history of Economics, and modern day examples are the National Accounts, Input-Output tables, and regional analysis. Briefly these attempt to probe the inter-relationships among the various parts of the economy. The analysis can be made more dynamic through comparison over time, between sectors, or with other economies, much in the same way as a single statistic can be made more meaningful if it can be compared with others in a series.

An aggregate analysis may show, for example, that a certain sector is declining (or increasing) relative to other sectors in the economy, or perhaps even absolutely. In the event of a declining sector, this may suggest that investments ought not be made there, but rather should be made in the growth sector. This, generally speaking, may perhaps be true, but it overlooks the possibility that specific investments in a growth sector may be unprofitable and that others in the declining sector may be

extremely profitable. (Also, a conflicting but equally valid policy conclusion may be drawn, namely, that the poor performance in a particular sector is due to the lack of investment for modernization, or of investments of the social type).

Most sport fishing evaluations conducted to date have been along aggregate lines. Numerous attempts have been made to find out the economic value of sport fishing within various political boundaries. These evaluations usually represent an attempt to assess the amount which sport fishermen spend within these boundaries. Sometimes the evaluation is made in net terms, but more often than not in gross terms, (and occasionally includes governmental expenditures on sport fishing as well as sportsmen's expenditures). Usually the amounts recorded are impressive, and these amounts coupled with the probable increase in the numbers participating in sport fishing present a very optimistic outlook for sport fishing as a whole. While there is no definitive statement as to the usefulness of these studies, other than as a statistical account of the part played by sport fishing in the economy, the values arrived at are often used as supporting evidence to the general case for more stocking, hatcheries, protection, basic research, etc., and sometimes in connection with specific developments as evidence that sport fishing is the best use of resources.

It is impossible within the confines of this paper to deal with all the possible objections to an aggregate analysis of sport fishing without dealing in detailed terms with the professed or implied objectives of the studies which have been conducted. However, the following considerations which the author believes constitutes the general objections to this type of investigation are presented as "food for thought".

1. An examination of the items of expenditure will show that transportation, food and accommodation usually are the principal components. Regrouping these components into a different set of "sectors" could suggest that increased social investment is required on constructing and maintaining roads, or that increased emphasis should be placed on technical training for motel operators, cooks, waitresses, etc.

2. The results are clearly affected by the income and tastes of certain segments of anglers, and the local angler or the angler who makes a minimum of expenditures and the fishing area which draws mostly this type of angler is largely "unrepresented".

3. If the results are considered as valid evidence in support of a greater share of taxpayers' funds then, for a rational choice to be made, similar analysis ought to be made for other "sectors". If "oranges" are to be compared with "oranges" (rather than "apples") one might total expenditures on power purchases, electrical appliances and gadgets, television and radios, etc. (and toss in the cost of TV repairs for good measure) to show how much people spend in connection with electrical power consumption, in a fish versus power controversy.

4. The results appear to have meaning, as far as sport fishing development is concerned, in the event of a major cataclysm affecting sport fishing resources. Grasberg for example defines "economic benefits" for the purpose of his study as the "amount of income (accruing to the residents of the Province), which is attribu-

table to the occurrence of salmon and which could not reasonably be expected to exist if the fish disappeared permanently".[1] Very few of the problems confronting sport fishing are of this magnitude.

(b) *Project Evaluation*—Project evaluation attempts to deal directly with the economic factors affecting a decision—in contrast to aggregate analysis which provides only descriptive and indirect evidence to aid in decision making.

Project evaluation, whether the project is public or private, uses the same mathematical technique to relate costs to benefits[2]—the discounting of future benefits to their present values. Using the concept of a conventional investment[3] (that is an investment having one or more periods of outlay followed by one or more periods of returns), a simple example can be illustrated as to how costs and benefits are to be related:

	Costs	Benefits				
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Current values	$10,000	$2,500	$2,500	$2,500	$2,500	0
		=$10,000				
Present worth discounted @ 5%	$10,000	$2,380	$2,267	$2,159	$2,056	0
		=$8,862				

Thus although the sum of the current benefits (in the years in which they take place) equals the costs, the present worth of these benefits (discounted at five per cent per annum) falls below the cost—in other words the project is uneconomic.

A specialist may consider the economist's function finished when he has determined this rather basic question: whether the project is economic or not (if uneconomic, the specialist may query whether the "true" value of the activity has been given its due recognition). The specialist who comes "project in hand" may be perplexed by the economist's concern with the economic design of the project. Briefly the economist's concern can be summarized as follows.[4]

(a) Benefits equal or exceed costs (the basic question discussed above).
(b) Each separable segment provides benefits at least equal to its specific costs.
(c) The scale of development is such as to provide maximum net benefits.
(d) There is no more economical means of accomplishing the same purpose.

In addition, the economist is also concerned with ranking of various projects, and in determining the proper sequence in which they should be undertaken[5].

Project evaluation may appear to be remote from the "central" problem in sport fishing. It is worth noting, however, that a great number of the developments in sport fishing are physical projects, and an additional number call for comparison

[1] Grasberg, Eugene. *Economic Benefits of the Atlantic Salmon to the Province of New Brunswick*, Fredericton, New Brunswick, 1956.

[2] See Sewell, W.R.D. et al *Guide to Benefit-Cost Analysis*, Resources for Tomorrow Conference, Ottawa 1962, for a description of the manner in which public projects are to be evaluated, and Bierman, Harold and Smidt, Seymour, *The Capital Budgeting Decision*, Macmillan, New York, 1960, for the evaluation of private projects.

[3] This useful concept is adapted from Bierman and Smidt, *op. cit.*

[4] These are the economic feasibility requirements used in Benefit-Cost Analysis.

[5] Krutilla, J. V., *Sequence and Timing in River Basin Development*, Resources for the Future Inc., Washington D.C., February 1960.

of cost and benefits even although no physical project is involved (the diversion of water from some other use to maintain water levels for sport fishing or vice versa represents a cost to one user and a benefit to the other). Again the "project" may not have to do with fish: a road for example may make the area more accessible.

In other words, most decisions concerning sport fishing can be thought of in terms of project evaluation. Astonishingly, very little published work appears on this type of economic investigation. Most of the discussion of the economic merits of a project, if indeed it exists, is not available for study, in contrast to the aggregate analysis where the data are readily available, if not actively promoted.

Some lessons from commercial fisheries development may illustrate the importance of the project evaluation type of investigation. These assume that the benefits of the project are directly related to the physical increase in numbers of fish (in contrast to some concepts of sport fishing where physical catch appears as only one factor) and are concerned with anadromous species.

1. One complete life cycle is required before there are any benefits from the project (Atlantic salmon for example commonly need six years to complete a life cycle). Several life cycles appear to be required before the full effects of the project occur. Thus the benefits may require up to twenty years before they materialize fully.

2. There appear to be inherent diminishing returns in many fisheries projects. Marts and Sewell[6] point out as more and more dams are added on a river system, more and more investment is required in the form of fish passage facilities. In contrast the number of fish which survive (in the upward and downward journeys) diminishes. While Marts and Sewell assume a series of dams, various combinations of things deleterious to anadromous fishes can be imagined (e.g. a dam plus industrial or domestic pollution).

Thus we have two general types of economic investigation; first, the aggregate analysis which provides an optimistic outlook to the future demand for sport fishing, and second, the project evaluation which provides (if limited to the physical effects of a given project) a rather pessimistic outlook to sport fishing supply. (If, of course, physical supply of sport fishes is not the governing criterion for the amount of satisfactions resulting from sport fishing, then the relationship between benefits and physical supply is not direct, and implicitly the present importance attached to "biological" projects for sport fishing is also questioned if the physical basis of sport fishing is questioned.)

Viewpoint

The problem of the viewpoint from which projects are to be evaluated is overlooked in much of the sport fishing literature. ***The Guide to Benefit Cost Analysis*** describes this problem as being "of fundamental importance to the economic analysis".

A person investigating sport fishing will come across a variety of viewpoints—those of the local and non-local angler; of the newcomer and the latecomer; of the resort owner and the sportsman; etc. As can be seen even among the direct or indirect

[6] Marts, M. E. and Sewell, W.R.D., "The Application of Benefit-Cost Analysis to Fish Preservation Expenditures: A Neglected Aspect of River Basin Investment Decisions", *Land Economics*, February 1959.

sport fishing users, there is a possibility for conflicting viewpoints. A public camp ground or tenting area utilized by sport fishermen may "rob the resort owners of some potential customers" or it may attract "outsiders" to the detriment of local anglers.

On a broader scale a development may be viewed from different viewpoints, a sport fishing development in one area may only serve to transfer patronization from another area (within the same province for example); similarly this could occur between provinces.

A definite example of how the economic evaluation is affected by the viewpoint is given in the Grasberg study. In evaluating the economic benefits of Atlantic salmon to the Province of New Brunswick, he includes as an item for federal expenditures on protection, research and management of Atlantic salmon (accounting for one-sixth of the total "economic" benefits). Needless to say, if this study had been carried out from a federal viewpoint this item would have emerged as a cost rather than a benefit.

Normally in investments "he who pays the piper, calls the tune"; that is, the project is to be evaluated from the point of view of the investor. In sport fishing evaluation, it would be quite logical for a resort owner to consider the economics of his investment only from his point of view, for a local group to assume a local viewpoint in respect of its investments, and similarly for provincial and federal governments to evaluate their investments from their respective viewpoints.

However, the actual situation may not be so straightforward. A semi-local viewpoint may be adopted by senior levels of government either "accidentally" or deliberately; a fisheries or sport fisheries viewpoint may likewise be adopted. Again, under the Fisheries Act, remedial actions may be required to be undertaken. In this case, the cost of the remedial action is borne by other than the federal government, in other words its costs are nil. In order for an economic evaluation to be made in this case it is necessary for a national viewpoint to be taken embracing both uses. The national viewpoint is the widest viewpoint possible, and constitutes the "ideal" viewpoint to the economist. It is recognized, however, that other viewpoints can be equally valid depending on the circumstances. Because the viewpoint can easily affect the evaluation (as shown above) it is desirable that the viewpoint taken be made quite explicit in economic studies.

Costs

Costs are given little or no attention in aggregate analysis (except for sportsmen's costs, some of which when incurred in the geographical area embraced by the viewpoint become "benefits"). By contrast in project evaluation they occupy a position of equal importance to benefits. Unfortunately space does not permit an elaboration of the types of costs which may be involved in a project. In passing, however, it might be noted that construction costs (if the project involves construction) are not the only costs, and considerable costs are represented by operation and maintenance and research and administration connected with the project. Because of the peculiarities of accounting systems, these costs may not be readily identified as being part of the project's costs.

Part II—Possible Methods of Evaluation

A variety of factors have been suggested as a basis on which methods of evaluating sport fisheries can be developed. Many of these suggestions were made in respect to the evaluation of other forms of recreation, but are presented below as they might relate to sport fishing. Classification of the possible methods of evaluation is mainly on the basis of the factor involved—time, catch, expenditure, distance, etc. (but also including such methods as the use of an educated guess, and the use of imputed prices and values). Where several methods focus upon the same factors they will be termed "variants".

Where the method can be traced to its originator this is done, and, where this is not possible, references or studies using the method are given where greater detail can be found. It should be noted that all of these methods are related to a given point in time—usually the present—and are essentially static. To assess the time accrual pattern of benefits would involve additional assumptions or the use of indicators or trends.

1. *Educated Guess*—This involves an assessment of the over-all worth of the benefits involved. No precise procedure can be established, although the person making the evaluation may use a variety of available information[7]. The use of an "educated guess" is always open to some question, since it is unlikely that two persons, working independently, would use the available information in the same manner or arrive at the same results. It would involve a minimum of expense compared to other methods, even if an "expert" were hired, and results could normally be available quite quickly. The method is probably used much more frequently in business and industry, where there is no direct responsibility to the general public, and where more systematic investigation is precluded by time considerations or by expense. Nevertheless the element of "personal judgement" on the part of the person making the evaluation under this method also arises in some other methods, such as when using the values arrived at for some other project.

2. *Catch*—It has been suggested[8] that a minimum value for sport fishing could be obtained by using the market value of the same fish caught commercially. This method is open to a number of criticisms, namely that it only attempts to measure part of the benefits received, that the cost of catching by hook and line is probably several times the market value of the catch (which would only serve to demonstrate that sport fishing is an inefficient method of catching fish) and that some species of sport fish are not marketed commercially.

3. *Time*—Several methods involving the use of time spent fishing as a basis of measurement (rather than as a unit of measurement) have been suggested. One variant sees the value of a day's fishing as at least equal to the wages the individual foregoes in order to fish. This "opportunity cost" approach may have validity where the individual does make this choice and where a day's wage represents his true sacrifice.

---

[7] For an example of an "educated guess" used in evaluating recreation benefits see Dales, J. H., *Supplement "A" to the Brief on Flood Control Measures for the Upper Thames Watershed, Benefit-Cost Analysis,* Upper Thames Conservation Authority, London, Ontario, December 1957.

[8] Sewell, W.R.D. et al *op. cit.* p. 29.

(He may jeopardize his employment, in addition to foregoing a day's wage). Difficulties are encountered in a number of circumstances: there may be other factors contributing to "absenteeism"; earnings may not be known such as for business or professional persons; and much of the sport fishing is usually done on weekends or vacations or by persons in retirement, in which case earnings are not foregone in a direct sense.

Another variant[9] sees recreation as complementary to work (in contrast to the above where the two are competitive). It considers that leisure as well as the direct amount of time worked contributes to real production, and consequently leisure can be credited with part of the value of real production. It avoids some of the objections to the first method.

Both variants, however, are not specific enough for what is demanded of them. No distinction can be made among a day's fishing, hunting, golfing or "idling" etc. What they appear to attempt to do is to put a value on leisure time as opposed to working time, but not on specific uses of leisure time.

One instance where a price has been placed on time is the Ullman and Volk study[10] where in calculating savings resulting from a new recreation area, they included a value for savings in time for both drivers and passengers. Their contention is "... that people would value their time more than the gas and oil saved..."

4. *Expenditures*—Use of expenditures made in connection with sport fishing forms the basis of the most popular methods of evaluation, if one is to judge from the number of studies which employ this as the basis of measurement[11]. The procedure involves the totalling of the expenditures which the sportsmen make in connection with sport fishing (or, conversely from a receipts point of view, the sales which businesses make to sport fishermen, the income from guiding and rental of boats, etc.). Some studies are interested in expenditures within a certain area, rather than fishermen's costs, in which case expenditures made outside the area are excluded. In addition some studies have attempted to determine the net income which the area derives from these gross expenditures[12].

These expenditures represent the "associated costs" incurred by the sportsman in utilizing the goods and services made available by the project. To the extent these expenditures are made in the area embraced by the viewpoint assumed, and to the extent that they represent increased net income to this area, these expenditures represent secondary benefits—not primary benefits as they are often misconstrued to be.

---

[9] This approach has been outlined by William F. Ripley of the California Department of Fish and Game and is described by Crutchfield. See Crutchfield, James A., "Valuation of fishery Resources" *Land Economics,* May, 1962.

[10] Ullman, Edward L. and Donald J. Volk "An Operational Model for Predicting Attendance and Benefits: Implications of a Location Approach to Water Recreation", *Papers of the Michigan Academy of Science, Arts and Letters.* Vol XLVII, 1962 (1961 Meeting)

[11] Most states, at one time or other, appear to have made surveys of the "value" of sport fishing to their economies. In Canada similar surveys have been conducted. See Benson, D. A., *Fishing and Hunting in Canada,* 1961 Canadian Wildlife Service, Ottawa, 1963; Grasberg, Eugene, *Economic Benefits of Atlantic Salmon to the Province of New Brunswick,* Fredericton, N.B., 1955 and Maheux, Georges, *Atlantic Salmon in the Economy of the Province of Quebec,* les presses universitaires Laval, Quebec, 1956. While these studies, strictly speaking, are not project evaluations, the method is often suggested for such purposes.

[12] See for example Grasberg, Eugene, *op. cit.* and Maheux, Georges, *op. cit.*

The variants of the expenditure method have been severely criticized largely because they do not measure primary benefits. Clarke questions "...how much of what the hunter spends is tied in the vanity of gadgetry, and status-seeking assertiveness in private transportation and accommodation...? Is true value to be measured in dollars?..."[13] Farina in discussing the high costs which result in restricting some recreation forms to exclusive groups raises much the same question, "are our recreation resources viewed primarily as economic asset? Are they to be developed primarily in terms of potential dollar return?"[14]

These questions are symptomatic of the problems which arise as a result of the excessive reliance placed on the expenditures as a basis for evaluating recreation benefits. Benefits may be measured in terms of dollars, as a common unit of measurement of all economic values, without ignoring the benefits which accrue to persons having little or no expenditures.

Crutchfield suggests that other surveys at the worst "...would bring us more useful information than the large sums now being spent on essentially useless studies of fishermen's gross expenditures".[15] While this criticism is generally valid, it does tend to overlook the importance of expenditures to the local area, and therefore the usefulness of the expenditure method when a local viewpoint is assumed.

5. *Distance*—The original method using distance is known as the "Hotelling Method" after Professor Harold Hotelling of the University of North Carolina, who suggested it in response to a request by the U.S. National Parks Service on possible methods of evaluating recreation benefits.[16] Several modifications and applications of this method exist.[17] In fact, the "Clawson Method" really deserves a special category by itself.

Distance is used as the basis of measurement since this (including the absence of the need to travel) is an essential element in enjoyment of recreation benefits. Thus the criticism of being concerned with the "vanity of gadgetry", is avoided.

Two assumptions are involved (1) that the same level of benefits accrue to all persons, and (2) that persons coming further just "break even"—that is their benefits equal their travel cost. Primary benefits are thus represented by the saving in travel costs, or "surplus", which accrues to persons coming lesser distances.

These assumptions may be criticized, since persons may value the benefits derived quite differently from each other, and persons coming "farthest"—and one would expect this to be the case—may enjoy benefits in excess of their costs.

[13] Clarke, C.D.H., "Wildlife in Perspective". *Background Papers,* Resources for Tomorrow Conference, Ottawa, 1961.

[14] Farina, J., "The Social and Cultural Aspects of Recreation". *Background Papers,* Resources for Tomorrow Conference, Ottawa, 1961.

[15] Crutchfield, James A., *op. cit.*

[16] His letter was originally published in the "Prewitt Report", U.S. Department of the Interior, National Park Service and Recreational Planning division, 1949 and is also quoted in ORRRC Study Report 24, *Economic Studies of Outdoor Recreation,* Outdoor Recreation Review Commission, Washington, D.C. 1962, p. 56.

[17] See for example Clawson, Marion, *Methods of Measuring the Demand for and Value of Outdoor Recreation.* Resources for the Future Inc., Washington, D.C. February 1959; Trice, Andrew H. and Wood, Samuel E. "Measurement of Recreation Benefits", *Land Economics,* August 1958.

Also, it is by no means certain that persons who come lesser distances enjoy benefits of the magnitude suggested. Local inhabitants (see the methods involving the concept of "alternatives" below) may consider their benefits as the saving in travel cost to their nearest next alternative, rather than being determined by the fact that an individual or group of individuals came long distances to enjoy the recreation facilities which the local inhabitants have on their doorstep.

In practice it is important to distinguish between "distance", as implied in the model based upon "concentric zones" which Professor Hotelling uses, and "travel costs" which he also uses. Two persons using one car may come 100 miles in terms of distance, but their (average) travel cost would be equal to the cost of 50 miles. Similarly their cost of travel per day diminishes as the number of days spent at the recreation facility increases, and the distance from the individual's place of residence to the recreation facility is not necessarily appropriate, as in cases where the decision to make use of the recreation facility is made "en route" or "on arrival".

The Clawson variant likewise uses a zone system, but it is based on population, i.e. each zone having the same population. Thus the rate of participation falls as the zones are located progressively more distant from the sport fishing site, and a relationship can be established between travel costs (i.e. distance) and the rate of participation. Assuming that prospective participants would react to the imposition of a fee in the same manner as an increase in travel costs, a demand schedule can be constructed showing the numbers who hypothetically would fish this particular fishing area, at various levels of fees. It is then assumed the economic value is represented by the fee which would maximize total revenue. The model is thus analogous to a situation where the fishing area is owned privately, and where the private owner attempts to maximize his total revenue.

A further modification has been to apply the Clawson variant to assess the economic value for a political unit (the State of Oregon) rather than a specific site.[18]

6. *Imputed Prices and Values*—Prices and values may be imputed using prices and values already established. In some cases, sport fishing benefits might be established on the basis of the prices a private operator charges for sport fishing privileges. Such prices may be "rod fees" or determined by the length or weight of the fish caught or a fixed price per fish.[19] Another example is the annual rental fee, under the leasing system which applies to some stretches of salmon rivers in New Brunswick. These leases, some yearly, others for a period of 10 years, permit exclusive use by the lessee, and the annual rental is determined through public auction.[20]

---

[18] Brown, William G., Singh, Ajmer, and Castle, Emery N., *An Economic Evaluation of the Oregon Salmon and Steelhead Sport Fishery*, Agricultural Experiment Station, Oregon State University, Corvallis, Technical Bulletin 78, September 1964.

[19] See for example "Now They Can't Raise Enough Trout". *The Financial Post*, Toronto, Ont., May 3, 1962.

[20] Another interesting feature in New Brunswick is the allocation of reservations on Crown Reserve Waters. These are open to residents of New Brunswick only, at a licence fee of $1.00 per person, and are not to exceed three days. Allocation among persons or fishing parties of the right to fish during certain specified days is determined by a draw system.

It is clear that the propriety of using existing prices depends on the degree of correspondence between the situation where these prices occur, and that pertaining to the project under evaluation. The use of annual rental fees obtained under the New Brunswick system, presupposes a similar situation for the river or project being evaluated, that is exclusive use of rather lengthy stretches of rivers for a definite period. This situation may not be too relevant in evaluating a project on a river which is open to the general public. Similar problems arise concerning productivity, location, availability of accommodation, ease of access, etc., which call for considerable adjustment to existing prices.

Another group of variants using the concept of prices is to inquire of actual or potential users, what prices they would pay for the fishing privileges they enjoy. This might be done in a number of ways: such as by asking "How much would you pay (per day, week, or season,) for the privileges now offered?"; or "How much would you be prepared to pay for the benefits from the project (increased catch, increased access etc.)?". Obviously what is being asked is "How much of the benefits you now enjoy (or how much of your potential benefits) are you willing to sacrifice, in terms of dollars, in order that you may continue to enjoy a remaining reasonable level of benefits in respect of your other costs (transportation, gear, etc.)?". In framing such questions, since they are hypothetical, attention would have to be paid to assumptions underlying them. Would prices be charged for other fishing areas? Would the individual be expected to fish the same number of days as he previously did? etc. Crutchfield for instance, recognizing that the institution of prices (even hypothetically) raises the question of curtailment of fishing time, proposes a survey of fishermen to establish to what extent their fishing time would be curtailed at various levels of prices.[21]

Such approaches have the advantage of placing the whole problem of the magnitude of primary benefits in the hands of those persons who enjoy them. It might be said that these persons are at least as well placed, if not better placed, than others to know the magnitude of the benefits they enjoy. It should be noted, however, that these approaches which involve the question "How much would you pay...?" or "How much would your fishing time be curtailed if...?" are more relevant where the institution of prices is being considered. Where such is not the case, such questions may only measure the amount of money the individual has available for spending on recreation. A pensioner, for example, may receive considerable enjoyment from sport fishing—indeed it may be one of the few forms of recreation available to him—but may not have sufficient income to pay anything for fishing privileges, without sacrificing some necessities of life.

In order to avoid such difficulties, a further variant has been proposed. This is to ask the question "How much are these fishing privileges worth to you?", in an attempt avoid measuring income available for recreation purposes, but still directing the question to the primary beneficiaries, and having values expressed in terms of dollars.

---

[21] Crutchfield, James A. *op. cit.*

7. *Alternatives*—The concept of alternatives is quite frequently used in measuring primary benefits for Benefit-Cost Analysis purposes. In the evaluation of hydro-electric power benefits for example, these are frequently established on the basis of the difference between the cost of production by one means and the cost of production by the next alternative means of production.[22]

Although the concept of alternatives has found a place in the measurement of other benefits, besides hydro-electric power, it does not appear to have found application in the evaluation of recreation benefits.[23] Yet the consideration of alternatives is always germane,[24] and some suggestions of the possible use of this concept have been advanced. One suggestion is that it can be used to set an upper limit to recreation values, that is that the value attributed to recreation benefits of a multiple purpose project cannot exceed the cost of providing these benefits elsewhere.[25] Another suggestion has been to estimate future demands for recreation within a particular area; with the problem then to satisfy these estimated demands at least cost among the projects which have a recreational content.[26]

Another variant involving the concept of "alternatives" would make use of the fact that fishermen normally fish a number of rivers and lakes in a season, or have done so in past seasons, or are acquainted with the merits of other lakes and rivers through conversations with fellow sportsmen. It can also be assumed that they tend to fish where they can achieve maximum enjoyment for the amounts they spend in connection with sport fishing. If the river that tends to offer this maximum enjoyment did not exist, then they would tend to fish their next best alternative. If in fishing the alternative higher costs are incurred (such as having to travel farther), then this represents an additional cost to the sportsman. The saving of this additional cost represents the primary benefits to the fisherman from having the river he tends to fish in existence. To put it another way, without this river he would go elsewhere and (presumably) have higher costs; with the river, he does not have to incur these additional costs.

A variant which follows a similar line of reasoning is that used in the Ullman and Volk study. Here the problem was to assess the attendance at and values created by a new reservoir area. This was done by a survey of persons attending more distant impoundments to determine the extent to which they would divert their attendance to the new reservoir. Benefits were calculated on the basis of the travel costs thus saved and, as mentioned before, also included a value for the saving in travel time.

---

[22] Sewell, W.R.D. et al, *op. cit.* pp 24-26.

[23] Dales for instance states "The value of recreational facilities raises new problems because it is difficult, and perhaps meaningless, to think of the cost of providing the same facilities by alternative means." Dales, J. H., *op. cit.*

[24] See discussion of Hotelling method above and the *Report of the Commission of Inquiry into the Puntledge* where it is stated that if the fish run were stopped altogether the sportmen would seek the next best means of recreation and "it is mere guesswork how great the loss would be."

[25] Sewell, W.R.D., *op. cit.*, p. 29.

[26] Spargo, R.A. "Benefit-Cost Analysis and Project Evaluation", *Background Papers, Resources for Tomorrow Conference*, Ottawa, 1961.

Part III—Conclusions

A matter of fundamental importance in economic evaluation is its role in decision making. Many statements as to the usefulness of economic evaluation can be found in sport fishing literature. A sample might include:

> "The values (the outdoorsman) represents, like those of the arts, are too fundamental and too important to be measured in mere economic terms"[27]
>
> "...while we are preparing for the future, we may find it politically expedient to use this crass argument of Dr. Crutchfield's, that puts the dollar value on our fish and game... But we also have always to keep in mind the other thing that Crutchfield was talking about, which are the unseen values, the values that can't be expressed in dollars and cents.
>
> "After all, we really stand for a way of life, not for something that in dollars and cents is worth more than some other alternative, and this we must never lose sight of."[28]
>
> "Figures must be used with discretion, because each economic situation has not only its dollar side but also its human side. If this were not true, any attempt to save salmon, no matter for whose benefit should be given up...(since)...activities which may affect salmon runs certainly create more dollar value than all the uses of salmon put together."[29]
>
> "Outdoor recreation produces many benefits... These benefits are not to be justified on a cost accounting basis. Like education, outdoor recreation is one of those elements of the full life that should be made available to the general public. But there are also important economic effects in the provision of outdoor recreation, and they should not be overlooked".[30]

The above quotations suggest that in addition to the economic value of sport fishing there are values of a different and "higher" order, which are of more consequence than the economic value. (If so, it follows then that development should be predicated on these values of the higher order, and that the economic values are of little consequence).

Thus this line of reasoning suggests that an alternative use of the resources can be justified only where the economic value of the alternative use equals or exceeds the economic value of sport fishing *plus* the values of the non-economic order. This can be expressed algebraically as follows: that sport fishing represents the best use of resources unless

$$V_a \geq V_s + S \qquad (1)$$

where Va represents the economic value of the alternative use; Vs the economic value of sport fishing; S representing the non-economic values derived from sport fishing (the values which cannot be measured in dollars and cents).

---

[27] Roderick L. Haig-Brown, in the foreword to *Distribution and Economics of the British Columbia Sport Fishery 1954* by S. B. Smith, Management Publication No. 4, B.C. Game Commission 1955.

[28] Larkin, P. A. *Address to B.C. Federation of Fish and Game Clubs* Seventh Annual Convention, Nanaimo, B.C. May 1, 1964.

[29] Grasberg, Eugene, *op cit.*

[30] ORRRC, *Outdoor Recreation For America,* Outdoor Recreation Resources Review Commission, Washington, D.C., January 1962 p. 75.

The basic question associated with this line of reasoning is whether we can be sure that there is not an A factor (similar to the S factor) which ought to be included on the left-hand side of the equation, that is whether it should not read:

$$V_a + A \geq V_s + S \qquad (2)$$

The most ardent advocate for sport fishing would find it hard to deny the A factor, if the alternative use were hunting since the activities are quite similar (a situation which might be relevant, for example, where sport fishing projects and hunting projects were competing for government funds). Similarly judging from the ORRRC statement and that of Haig-Brown given above, the A factor would seem to be present in all forms of outdoor recreation.

Is the A factor only present in outdoor recreation? Larkin refers to sport fishing as being "a way of life". Surely this description is also apt (and probably more so) for commercial fishing, farming and probably for a great many other occupations and professions. So we can assume that the A factor is quite widespread, but we may ask the question "It is general?". Grasberg would seem to answer in the affirmative in his statement "each economic situation has not only its dollar side but also its human side" (although admittedly he appears only to be attempting to establish the existence of the *S* factor). A reading of the arguments advanced in favour of other goods and services would suggest that their "human side" (if not embodied in the economic value of these goods and services) ought to be considered as a special factor. Is a book only to be valued in terms of its price? Is the price of electric power in terms of cents per kilowatt-hour, particularly if this has shown a decrease over time, really representative of the ease, comfort, and entertainment it can offer? Are roads only a means of conveying goods and people from point A to point B? The A factor may even be related to the *S* factor. Has not electric power (and other forms of energy) shortened the work-week and freed us from domestic chores so that we have more leisure time to devote to sport fishing among other things? And do not roads provide us among other things with means of getting to sport fishing areas quickly, cheaply, safely and more often?

(The vague nature of the *S* factor might be noted in passing. Not only is it a curious mixture of healthful exercise, a means of avoiding mental breakdowns and a means of communicating with and learning about nature[31] which cannot be identified in any precise sense, but it is also unmeasurable either in dollars and cents, or on any other basis. Consequently the *S* factor cannot serve as a basis for sport fishing development, if we are not sure of what this factor is, how to measure it or whether it would be increased or decreased as the result of a particular development.)

Thus far, the discussion has assumed, in accordance with many statements in the sport fishing literature, that the *S* factor exists independently of the economic value of sport fishing, and that if the *S* factor exists for sport fishing, similar factors also exist for other forms of human activity, and that these would tend to offset each other and possibly cancel each other.

[31] ORRRC ibid p. 75. Other persons may "see" other "unseen" values in sport fishing (or in recreation generally).

The economist holds that these special factors are taken account of implicitly by the individual in making his choices among goods and services—especially among goods and services marketed commercially. If a pricing system were somehow introduced into outdoor recreation, then the individual would have to weigh his satisfactions from sport fishing, against the satisfactions he would derive from other uses of his income, including other forms of outdoor recreation.

Even as matters stand now, the sportsman has costs of sport fishing, so that he probably is weighing the satisfactions he would derive from new sport fishing equipment compared with a new suit, etc.

For these reasons, the economist regards the proper basis of comparison to be the economic values concerned, that is, sport fishing represents the best use of resources unless

$$V_a \geq V_s \qquad (3)$$

One can legitimately query whether the various methods outlined in Part II adequately measure Vs (similar problems arise in choosing methods to evaluate other forms of human activity, that is Va), but this is not the same as introducing the S factor (or the A factor) as a criterion for decision making.

As has been explained in Part I, the viewpoint is of fundamental importance in determining the proper method of determining Vs, and its magnitude. The net income derived from sport fishermen's expenditures, for example, is the proper method for evaluating Vs where the viewpoint taken is a local one, and where there are no local sport fishermen. Some other of the methods may similarly be appropriate for different situations and viewpoints. Without going into detail it should be clear that for a comparison to be made, both Va and Vs should be evaluated from the same viewpoint and using similar methods as far as possible.

Time and space do not permit detailed investigation of the relevance of all the methods and techniques. However, two general types as described in Part II, and which seem particularly appropriate for evaluations from wider viewpoints, will be contrasted. The first is the Clawson Method, which assumes that the value of a sport fishing area can be ascertained by estimating the maximum returns which would accrue to a sole owner. (It should be noted that while the model does not give this sole owner full monopoly powers—he cannot discriminate between persons on an individual basis, nevertheless it does give him monopoloid powers). The second is the Alternative Areas Method, which assumes that the individual is acting rationally (i.e. he has compared the various alternatives, and has allocated his expenditures in a manner which will provide him with maximum satisfaction). The model then assumes that some change occurs which forces him to choose the next best alternative means of satisfaction. The extra money costs to him in obtaining these satisfactions, measure the benefits involved. For practical purposes, the method assumes that the alternatives are in both instances sport fishing areas (although conceptually at least, other activities can be included). The value of a fishing area can then be expressed by the additional costs which the individuals would have to incur to reach their next best alternative area.

Before commenting on these methods, it is worthwhile noting that analogous methods exist for the evaluation of other benefits. The *Guide to Benefit-Cost Analysis* states:

> "The value of direct benefits of a hydroelectric power project may be determined in one of two ways:
>
> (a) By estimating revenues expected from the sale of the power or energy (based on what the consumer would be willing to pay) or
>
> (b) By estimating the costs of producing the power or energy by some alternative means.
>
> The latter is the generally accepted method for public agency evaluations. Private agencies usually employ the former method."

and

> "For a public agency, the value placed on the gross direct benefits of a hydro project is equal to the total cost of power or energy from the lowest cost alternative source."

It should be noted that in private power, the developer usually does not have true monopoly powers, since the state usually regulates the rates and other conditions (on the other hand he may have some monopoloid powers such as being able to discriminate between domestic and industrial users). Again electricity is competing with other forms of energy, and the relative prices of these other forms of energy will set limits on the expected revenues to be received by the private developer.

Thus the nature of the sole ownership in the Clawson Model becomes one of the main points of discussion. Its relevance can be seen; if we assume several separate fishing areas within the same geographical area (i.e. so that there is no difference in distance and hence in travel costs), that each of these fishing areas is identical in "quality" (i.e. having identical access, scenery, probability of making a catch, etc.), and that the sport fishermen are equally informed, we can assume that the sport fishermen will patronize fishing areas in a proportionate fashion (e.g. if there are five such fishing areas, each will end up with one-fifth of the fishermen).

Now let us suppose that one of these fishing areas is purchased from the state by a private owner, who does not sport fish, but regards his purchase as an economic investment, and attempts to maximize his returns from it. If he has the required data on the sport fishermen who fished his fishing area previously, he can then apply the Clawson Method to determine the fee at which his returns would be maximized. However, he will not be able to collect this fee since, by assumption, other identical areas exist, and the sport fishermen have perfect knowledge of this. Thus the Clawson Method would seem to be relevant where:

(a) There are no other close alternatives

(b) Alternatives exist, but similar fees are charged

(c) Alternatives exist, but sport fishermen (such as foreign visitors) have no knowledge of them

(d) The number of alternatives and their capacity is so small, that the influx of sport fishermen (who used to patronize the fishing area now in private hands) has a negative influence on the "quality" of sport fishing at these alternative areas. (In which case, the private individual may ultimately receive at last part of the returns implied in the Clawson Model.)

The other point is that if we use this method, then we must also use a similar method (that is, one embodying the concept of a private owner) to evaluate other public projects. Here again we are led into the consideration of alternative means of "production" similar to the above.

Some of the limitations to the Alternative Areas Method have been revealed through empirical study.[32] Many sport fishermen fish a variety of fishing areas while others concentrate on perhaps one or two (this would seem to undermine the assumption implicit in the Alternative Areas Method that the fishermen through maximization of satisfaction would end up fishing in one area only) and that for many sport fishermen the fishing area offering them the nearest or almost equivalent satisfaction is one which they by-passed en route.

These findings may seriously question the conceptual adequacy of the method. However, since the method was only one of four being tested it was not probed too deeply. For example, it might be that the sharing of certain expenses (i.e. the economies of scale obtained through the individual participating as part of a fishing party) provides a different maximization of satisfaction over what would be the case if the individual alone met the expenses. Similarly, the maximization process might be influenced by whether or not the sportsman was accompanied by his wife and family which might rule out certain alternatives. Persons who by-pass their alternative may in fact be experimenting with maximizing their satisfactions (although such continuous experimenting may also become "a taste for variety" which, if prevalent, would seem to be sufficient to dismiss the method). Thus, there may be room for further investigation which would remove some of the present difficulties which are evident in the empirical findings. Such an investigation by use of a questionnaire might include, for example, data on the previous year's fishing pattern, the present year's fishing pattern (which is the only empirical evidence now available) and next year's intentions. For the present year, in addition to information on the composition of the fishing parties for the area under review (which is the only empirical evidence now available), similar data might be requested for trips to other areas. Certain *direct* questions might be asked as to how the individual made his choices, and under what circumstances.

(Such an investigation might provide a means for refining the Alternative Areas Method, or other methods. For example, the sport fisherman who by-passes his alternative has important implications for the Clawson Method. Will he pay any sort of a fee, and if so, how much? Or are the only persons who would

[32] Spargo, R. A. *Evaluation of Sport Fisheries: An Experiment in Methods* (Draft), Economics Service, Department of Fisheries, Ottawa, June, 1964.

pay the fee, the same persons who otherwise would have to incur greater costs to fish their next best alternative? On the surface, at least, there appears to be some possibility of linking the Clawson and the Alternative Areas Methods.)

It is recognized that such a questionnaire would focus more on "economic questions" than on providing "economic answers". However in addition to providing us with a more concrete idea with how the sport fisherman makes the choices he does, it may provide a means for adjusting methods to provide a closer measure of V_s.

SUMMARY OF DISCUSSION

Panel I (b): Methods and Techniques of Evaluation.

The author presented a brief summary of his paper pointing to the many considerations to be taken into account in approaching the problem of methods or techniques of evaluation. Type of economic analysis, viewpoint, and costs, in addition to benefits, are important elements in an economic evaluation.

Three methods have received considerable attention. These are:

1. The Expenditure method which is based on the amounts which individuals spend on sport fishing.
2. The Clawson approach which seeks to establish a hypothetical demand curve based on travel costs.
3. The Alternative-Areas method which seeks to value the economic benefits on the basis of the additional costs the individual would have to incur to fish another area offering similar sport fishing enjoyment.

The latter two seem more useful for wider viewpoints, while the first can be appropriate from a purely local viewpoint.

It was suggested that considerable confusion has been caused by the traditional emphasis in sport fishing literature on values of a non-economic nature.

In the discussion which followed the differences in the nature of the economic evaluation resulting from national, provincial, regional or local viewpoints, and the necessity of choosing the appropriate method or methods were brought out. The need for simple methods which would give quick answers, are desirable from the resource administrator's point of view; complicated methods which do not provide answers quickly might be rejected.

The necessity for choosing the proper method for the particular viewpoint and situation was emphasized. Studies conducted without consideration of objectives may not provide the necessary information to be of value in decision making.

It was recognized that while quick and simple methods would be desirable, the nature of the problem and the complexities involved may also necessitate the use and development of more complex methods.

Continuing research in the fields of both Benefit-Cost Analysis, and methods of evaluating sport fishing is obviously called for, in spite of the useful progress already made.

II—THE ECONOMICS OF MANAGEMENT

(January 6, 1965, 10:30 a.m.—12:05 p.m.)

PANEL MEMBERS

Chairman

A. L. PRITCHARD,
Director, Conservation and Development Service,
Department of Fisheries of Canada,
Ottawa, Ont.

Author of Background Paper

WILLIAM M. WHITE,
Chief, Division of River Basin Studies,
Bureau of Sport Fisheries and Wildlife,
United States Department of the Interior,
Washington, D.C.

Other Members

K. R. ALLEN,
Biological Station,
Fisheries Research Board of Canada,
Nanaimo, B.C.

G. E. COULDWELL,
Director of Fisheries,
Saskatchewan Department of
Natural Resources,
Prince Albert, Sask.

R. R. LOGIE*
Chief, Fish Culture Development Branch (Maritimes)
Department of Fisheries of Canada,
Halifax, N.S.

* *Present address and title: Assistant Deputy Minister of Fisheries (Operations), Department of Fisheries of Canada, Ottawa, Ont.*

Panel II, "The Economics of Management." Left to right, R. R. Logie, K. R. Allen, A. L. Pritchard, William M. White, G. E. Couldwell.

THE ECONOMICS OF SPORT FISHERIES MANAGEMENT

by

William M. White

The primary economic objective, I believe, of the public manager of a sport fishery resource or of any natural resource should be to use his ever-limited financial and manpower resources in such a way as to maximize on a sustained basis the contribution of the fishery to the needs and well-being of people. That is, the manager should endeavour to employ the "economic factors of production" available to him in such a manner as to satisfy as fully as practicable man's wants in relation to the fishery and its supporting fishes. To supply these wants requires increasingly that resource stewardship and husbandry be of the highest efficiency in the face of sharpening competition for water and living space on the one hand and for funds and manpower on the other.

In maximizing the contribution of the fishery to human wants and needs, management must consider a variety of both qualitative and quantitative aspects. Herein lies many a difficult decision for the manager and economist alike, for the needs of individual fishermen cannot be satisfactorily met by blind attention to the wants of the average man among the concerned public. The aggregation of wants to be met conceals a great diversity of demand. These diverse wants, while primarily directed to purposes of sport—embracing the thrill of pursuit, achievement of fishing skill, and bringing a trophy to creel—include also the related interests of esthetics; study and appreciation of nature; regeneration of the spirit, mind, and body; and frequently the garnering of food. One man's satisfaction may be a full creel of fish for food and another's a single trophy fish. A third will be abundantly rewarded merely by the sight of a graceful trout preferably in a placid pool below a waterfall, but acceptably to some, even in the marginal habitat of a stream or pond close at hand. The important thing is that our client will have experienced a quality of satisfaction that will urge his recall of the event and his physical return to the sport.

Depending on the situation and the clientele, the immediate objective of management may be to preserve a rare or endangered species, to restore a depleted fishery, to establish a new fishery or to re-establish a fishery rather than to immediately maximize the contribution of an existing fishery on a sustainable basis. But the latter should remain the primary and ultimate objective. Only the means and the economics should be varied.

Secondary objectives which may be appropriate, depending upon circumstances, include accomplishment of the primary objective:

(1) at the least cost for management in terms of funds and manpower,

(2) with the least disruption of the ecological complex,

(3) with the least interference with man's utilization of other water and related land resources, or
(4) with the greatest benefit to suppliers of goods and services catering to the primary beneficiaries.

At times the latter may rank as a coequal primary objective and I shall later develop an example.

Given the stated objective of maximizing satisfactions, a number of facets of the economics of management may be examined. The primary beneficiary of sport fishery management—the fisherman—normally receives no direct monetary benefit. Rather, he receives pleasure or satisfaction from the fishing, an intangible benefit which almost by definition is unmeasurable, but which may be assigned a derived or judgment value based on some concept of willingness to pay or alternative benefit foregone. He may, however, receive a tangible benefit from the management of the fishery. This benefit has direct or indirect monetary value. For example, he may be provided fishing at a lower cost than would have been the case without management either by reason of not having to pay as high a cost for travel and other associated costs or by not having to pay a specific charge or as high a charge for the privilege. In addition, secondary but very significant benefits from management flow to the suppliers of goods and services catering to the fisherman and to the management program. He may also receive a tangible benefit in the fish he catches. This benefit has direct or indirect monetary value depending on whether the fish are marketable or whether they replace a purchase that would otherwise be necessary. Additionally, the fish may be of higher quality than those obtainable in the market, making their value greater. Management can add to these values by increasing the catch per unit of effort and improving the quality of the catch.

In the evaluation of a particular management program in isolation, there may be little merit in attempting to reduce the benefits to monetary terms. Nevertheless, the costs should be compared with those of alternative programs which show equal promise of providing similar benefits. The prospective benefits as well as the costs should be quantified in some way so that a judgment of reasonableness of the program can be made.

Extreme care must be made in comparison of alternatives to assure that they are truly comparable. The benefits must be comparably desirable and useful to the client. They must also be fully measured with equal care. For example, in evaluation of the effectiveness of hatcheries dependent on wild brood stocks, particularly with anadromous fish runs, it was common in pioneer efforts to discount to zero the contribution that the brood stock might have made if it had been left to propagate in the natural environment. Even today, this factor is in many cases discounted or ignored. Also, with hatcheries, evaluation all too often has been based on the quantities of the immediate hatchery product rather than on the ultimate yield to the creel which requires a comprehensive review of habitat and environment conditions, analysis of fishermen catch, legal institutions, demand characteristics, and the like. Likewise, with other facilities for fishery

management, evaluation frequently has been made on the basis of capacities or other factors bearing questionable relationship to the ultimate desired product and frequently with but cursory consideration of alternative means of accomplishing the objective.

For the case of fishery improvements proposed with multipurpose water developments in the United States, benefits for some years have been reduced to monetary terms. This has proved desirable in order that the benefits from the varied and often competing purposes of water development can be integrated and a balanced plan formulated. For many years, judgment values for a fisherman day were used that were based on total expenditures incurred by the fisherman in connection with his participation in the sport. Recently, values for fisherman days have been derived from a cursory survey of charges assessed on private areas for the use privilege, to which informed knowledge and judgment were applied.

These so-called administrative values range from $0.50 to $6.00 per day and are intended to be net of all associated costs. In effect, they represent estimates of what a perfectly discerning, hypothetical private operator of a project area could net from the sale of fishing privileges. Incidentally, similar unit values have been established for hunting. The unit values have been adopted in practice by all concerned federal agencies of the United States and they provide a useful basis for judging the merits of fishery management proposals in connection with federal water development programs. They are used not only for comparison among alternative fishery proposals but also for comparison of fishery proposals with proposals for other types of use of the water project facilities. In addition, these standard administrative values are useful for all related economic analyses in water development programs such as establishment of benefit-cost comparisons for justification purposes, cost allocation among purposes, and determination of cost-sharing arrangements for beneficiaries.

Of course, standardization of fisherman-day values does not solve all economic problems of sport fishery management even as related to water resource development. The range of values permits assignment of a particular value judged to be applicable to the type and quality of fishing involved, but special problems remain which are associated with fisheries of unique character and high intangible value.

Evaluation of such costly management methods as the planting of catchable-sized fish requires consideration of the benefits and costs not only in terms of angler days and related monetary values, but also in terms of larger social questions. We must ask if the segment of the public served by this method could be equally served in other ways at the same or lesser cost. In other words, our evaluation must be as comprehensive as possible. It is not enough merely to relate the direct costs of management to the judgment values assigned to the fishing benefits; all related costs and benefits, both intangible and tangible, monetary or not, should be considered. If acceptable fishing can be provided by planting of catchable-sized fish at locations where fishing could not otherwise be provided, such as in intermittent seasonally flowing streams near metropolitan areas,

special benefits as well as lowered travel costs may accrue to the fisherman which fully justify the high management costs.

Economic considerations should enter more fully into management programs by way of benefit-cost comparisons of alternative and somewhat competitive phases of management such as research, enforcement, stocking, and habitat manipulation. Such comparisons are both technically and practically difficult; hence they have rarely been made. To a large degree, the emphasis among these phases is dictated by what is acceptable to a public conditioned by long-standing bias, what is legally possible, and what is appropriate to the general state of the art of fishery management. Some significant comparisons of stocking and habitat manipulation have been made, but other comparisons, to my knowledge, have not been attempted or have been so in only a superficial way. It seems obvious that such comparisons should be required, in so far as possible, as a prerequisite for a properly balanced management program. I can only commend them to future attention by both managers and economists.

In conclusion, I should like to recite, as an example of the potential benefits of an economically rationalized sport fishery, the development of the Fort Apache Indian Reservation in our State of Arizona. Our Government has taken a particular interest in the economic betterment of the Indian and one of many means selected is the development of tribal recreational resources. The Division of Fishery Management Services of our Bureau is in the forefront of such activities. The 1.6-million-acre reservation in point contains about 50 percent of Arizona's present trout stream mileage. Ten man-made impoundments were constructed to add about 935 surface acres of trout water. Thus the area can now provide a more significant portion of total fishing opportunity in this water-short State.

Permit fees charged to fishermen are designed to recover only the administrative costs of the tribal enterprise—the salaries of about ten people, and certain expenses. Permit fees are set at 60 cents for the first day and 30 cents for additional consecutive days. However, the principal tribal benefits are derived from the $4.82 average daily expenditures by fishermen on the reservation for lodging, boat rental, gasoline, and other items. The latter expenditures generate a gross revenue on the reservation of over $1 million annually. As a result of the fishery management effort this is expected to increase by 5 times and to provide direct employment for 250 tribal members by 1974. An additional $8 is estimated to be expended on an average by each of these fishermen while off the reservation, a substantial benefit to the State of Arizona.

What are the costs? Tribal capital investments to date are about $2 million of which approximately half has been for reservoir and access road construction. The balance has been expended for facilities to provide lodging, food, and similar services. I assume that land costs may be considered to be negligible.

Net profits from the operation, exclusive of the costs of stocking (which has been a federal responsibility) are reported at 15 per cent per annum, computed after appropriate deductions for depreciation of facilities and repayment of capital to the tribal treasury. Each facility is planned to return its capital investment within 20 years.

Calculated another way, a new capital investment of $2 million to be amortized at 6 per cent over 20 years would represent the equivalent of $170,000 annually. If the annual stocking rate of 80,000 pounds were costed at $1.50 per pound, or $120,000, and administrative costs of $44,000 were added, total annual costs would be $334,000. Trout fishing benefits would be calculated at a minimum of $2 per fisherman-day using the present schedule of administrative values. This would place 1964 fishing benefits at $584,000 which, compared to annual costs of $334,000 would indicate a benefit-cost ratio of 1.75, a highly favorable comparison. Other secondary and intangible values accrue to the tribal members which are not measured in this comparison. They have better fishing, better roads, better services, and higher individual incomes than they would otherwise have.

Whether or not the tribal council has examined exhaustively the alternative possibilities for investment, I cannot say. But it is obvious, I believe, that they have not only selected an economic use for their funds but they have selected an enterprise well adapted to the historic affinity of their people for the out-of-doors. It provides wholesome employment for their people while exploiting a renewable resource of their lands.

We conclude that the methodology of applying economic analysis to sport fishery management is in its infancy. There will be many pitfalls during the period when specific techniques are being developed and tested. Until methodology is perfected, the results would provide a frail single reed for the planner. However, the necessity for rigorous justification of management measures seems to make it imperative that we develop these techniques as a *support*, though not as a sole criterion, for management decisions. As in any other phase of human activity, there will never be a complete substitute for good judgment which weighs the best economic, social, and other factors that are available as a basis for decisions.

SUMMARY OF DISCUSSION

Panel II: The Economics of Management.

Following the presentation of a paper on the Economics of Sport Fisheries Management, the Chairman thanked the author and noted the general agreement on the place for economic evaluation in the field of resource management as well as the difficulties in deciding upon the methods of collection and selection of the appropriate data for economic evaluation.

The discussion which followed included a brief outline of the historical development of fisheries management where it was noted that only in the later stages of development did monetary evaluations enter into the picture.

Two approaches to management were cited as being research by biologists on the resource and by economists on the users of the resource. It was recognized that this plea for research highlighted the need for more data and more funds by which to secure these data.

Another point raised in this discussion centered upon the difficulties of evaluation but this was admitted to depend upon the complexity of the subject treated. The study of living organisms (human and animal) was acknowledged as difficult.

The difficulty of economic evaluation and the late entry of economists in resource management was not believed to indicate the absence of economics from the field. The choice to the administrator was stated as not being the presence or absence of economics but rather as being between good and bad economics.

It was suggested that despite the dangers inherent in short-cut methods of evaluation sometimes used in resource management, unless economists provide simple methods for valuation purposes which administrators can use themselves, the economists will be asked to provide answers with their more complex models for each particular problem which arises.

While it was generally admitted that benefit-cost analysis is vital to the administrator, it was pointed out that economic criteria cannot be the sole determinant in administration. The need for the administrator to be supplied with the best contributions of the various disciplines as well as his need to be fully aware of their individual limitations was realized.

III—RESEARCH REQUIREMENTS

(January 6, 1965, 1:30 p.m.—4:30 p.m.)

PANEL MEMBERS

Chairman

LOUIS LEMIEUX,
Director of Wildlife Service,
Quebec Department of Tourism, Fish and Game,
Quebec, P.Q.

Authors of Background Papers

LIONEL A. WALFORD,
Director, Sandy Hook Marine Laboratory,
Bureau of Sport Fisheries and Wildlife,
United States Department of the Interior,
Highland, New Jersey,

T. G. NORTHCOTE,
Fish and Game Branch,
British Columbia Department of Recreation
and Conservation and The Institute of Fisheries,
Vancouver, B.C.

N. H. MORSE,
Head, Department of Economics and Sociology,
Acadia University,
Wolfville, N.S.

Other Members

C. J. KERSWILL,
Director, Arctic Biological Station,
Fisheries Research Board of Canada,
Ste. Anne de Bellevue, P.Q.

P. A. LARKIN,
Director, Biological Station,
Fisheries Research Board of Canada,
Nanaimo, B.C.

K. C. LUCAS,
Assistant Director, Pacific Area,
Department of Fisheries of Canada,
Vancouver, B.C.

ANTHONY D. SCOTT,
Department of Economics,
University of British Columbia,
Vancouver, B.C.

Panel III, "Research Requirements." Left to right, T. G. Northcote, K. C. Lucas, Lionel A. Walford, N. H. Morse, C. J. Kerswill, P. A. Larkin, Louis Lemieux. (Missing, Anthony D. Scott.)

RESEARCH NEEDS FOR SALT-WATER SPORT FISHERIES: EXPERIENCE IN THE UNITED STATES

by

Lionel Walford

Recent Growth of Salt Water Sport Fisheries

A dramatic rise in salt water sport fishing began in the United States during the first decade after the second World War. This is the result of a number of influences. The most obvious among these are the post-war boom in technology and industrialization, the mass movement of people from interior rural areas to coastal cities, the general increase in leisure with the consequent growing demand for recreational opportunities; and the expansion and improvement of highways to shore resorts. By 1960 over six million anglers representing all states in the Union were fishing at one time of the year or another along the United States coasts of the Pacific and Atlantic oceans and the Gulf of Mexico. They were spending about 626 million dollars in pursuit of their sport. And their numbers were increasing by close to 350,000 a year. This prodigious growth has stimulated and has also been stimulated by a parallel growth in industries and services that cater to sport fishing. Such for example is the manufacture of tackle and of small boats; and retail shops specializing in anglers needs; operation of charter and party boats; and marinas, boat repair and storage facilities, motels, restaurants and so on. Small communities all around our coasts owe their prosperity to sport fishing; the livelihood of many people depend upon it.

Thus the growth of our sport fisheries has involved a considerably larger portion of the public than that actually engaged in fishing. And it has brought about many changes in our use of sea fishery resources and in the public's attitude about them which must give direction to the research requirements in a marine game fish program. These changes affect the motives for fishing, the species of fishes exploited, the seasonal and geographical distributions of fishing effort, and the intensity of fishing. They may also affect our old concepts of "rational exploitation".

Characteristics of Sport Fishermen and Fisheries

In planning fishery research about sport fisheries, the more we can know about sport fishermen, their interests and fishing habits, the better. The primary concern of the average angler is recreation—a day's fishing on the beach or in a small boat alone or in the company of friends, testing his skill in attracting a fish, and in overcoming one that puts up a hard fight. He wants a reasonable chance of

catching respectable numbers and sizes of fish worth photographing, talking about, storing in his deep freeze, and distributing among his friends. He hopes to land a trophy specimen some time in his life. He can measure the reasonableness of his chance of achieving his goals by the fortunes of other anglers about him, that is, by the frequency of their enviably big specimens and by the quantity and quality of specimens which they catch. However, being independent of profit motive and market requirements, an angler is free to stop fishing whenever he wishes. Even if he fails to catch anything he attaches considerable value to his day of recreation.

Sport fishing is diffusely though unevenly distributed in space and time. It is carried on at all hours of the day and night all along our coasts wherever people have access to the water and climate permits, and whenever the weather is favorable. It is carried on at the water's edge, on piers and jetties, and on craft of all sizes ranging from skiffs to ocean going yachts. It is carried on by divers. Sport fishermen's tastes are extremely variable. Many limit themselves more or less to a particular species, such as billfish, tuna, striped bass, salmon, tarpon, bonefish and other such that require special techniques or equipment. Altogether however, United States salt water anglers catch any kind of fish that will take a hook and line. That includes well over 200 species.

Size of Sport Fisheries

The average salt water angler catches about 100 fish in a year. To him this seems like a modest amount; and it is hard to believe that the total of all other people fishing like himself could add up to a significant quantity. But it does. This was brought out in a nation-wide survey which the United States Bureau of the Census conducted for the Bureau of Sport Fisheries and Wildlife in connection with the last census. From this survey it was estimated that in 1960 salt water anglers caught over 1.4 billion pounds of fish. The details of the statistics brought out by the survey are as astonishing as the grand total itself. For they show that the marine food fish species which can be caught on hook and line are yielding to sport fishermen significantly large portions of the total national sea harvest. Indeed the majority of them are yielding much larger catches to anglers than to commercial fishermen. *Considering only the fishing in waters off the United States coasts* in 1960, anglers took from the Atlantic about 84% as many pounds of cod as commercial fishermen, three times as many of mackerel, 15 times as many of bluefish. From the Gulf of Mexico they take about 12 times as many pounds of groupers, 22 times as many of sea trouts. From the Pacific they take more than a third as many pounds of rockfishes, 16 times as many of barracuda, and so on. Where in 1960 each of 43 categories (such as flounders, sea trouts, rockfishes, spear fishes) yielded 10 million pounds or more to anglers, only 26 categories yielded that much to commercial fishermen. Thus many fin fishes that had formerly been of minor importance are now yielding to anglers the equivalent of substantial commercial fisheries. Compare for example anglers' catch of sea trout in the Gulf of Mexico and the commercial catch of haddock in the North Atlantic (Table 1).

The Need for Sport Fishery Statistics

Several species that had been classed as "potential resources" appear now to be fished very intensively. But in what measure of intensity? When commercial fishery statistics accounted for the great bulk of the sea harvest, as they did until recently, they probably sufficed for reasonably accurate estimates of the total quantities caught, the effort spent in the catching and the geographical distribution of catches. They could be used for measuring relative abundance, for indicating trouble spots, and for evaluating the effects of remedial action. But this is true now for only certain principal fisheries. For the rest, the relative proportions of catches by anglers and those by commercial fishermen varies among different species (Table 2), areas and seasons; and it changes from year to year. Consequently commercial fishery statistics provide only a partial accounting of the national sea harvest.

Thus a fundamental need in a program of sport fishery research is comprehensive, systematic, accurate statistics. How to gather these is in itself a knotty problem for research. The objective is to estimate the total numbers of each species of fish caught, the weight of the catch and the numbers of fishermen. It is desired that these estimates be made by small geographical areas, such as counties, and by monthly periods. Other useful information would be the location and time of capture, the number of hours spent fishing and the method of capture.

Consider now the diverse elements of this problem: the far-flung distribution of sport fishermen, the wide variation in their fishing habits, the number of species which they catch, the continually changing composition of the catch as the fish move from one area to another. Obviously the statistical system must be based on a scientifically designed sampling plan. This requires considerable preparation. The more information that can be assembled about the geography of fish and fishing the better will be the design. This means searching literature, ferreting out old unpublished records such as log books, interviewing fishermen and organizing their collective experience.

From the materials thus gathered, the requirements of the sampling plan can be stated. The plan itself is a task for a highly sophisticated statistician. It should of course be tested by a pilot project in one or two areas of intensive fishing. Results of the pilot project will provide the basis for subsequent improvement.

A statistical system such as I have outlined requires teams of field agents strategically located, and equipped with fast moving vehicles such as airplanes and power boats so as to cover as large an area as possible. The information collected would be organized by data processing equipment.

All of us in this meeting probably agree that catch and effort statistics are absolute necessities in a marine sport fish program. I would go so far as to say that if we were limited in the beginning to only one activity, I would choose to start the statistical system—but only if we had enough money to start it properly. Unfortunately, it would take a lot of money, much more than we have yet been allotted, and since statistics are almost repellingly lacking in glamor, this money is the hardest to get.

Natural History of Species

Even if it had been possible to organize the statistical system in the beginning, we would have found it necessary to start biological studies as soon as possible, for in the last analysis the heart of the sport fishery research program must be the natural history of species. Although the term *natural history* has long been out of fashion if not in disrepute, it deserves rehabilitation; for it includes all studies about life of a species—its populational structure, life cycles, patterns of distribution, habits and behaviour, and the effects of environmental parameters upon all of these facets of biology. In developing the marine game fish program in the United States we have chosen to strike a compromise between two points of view which are described much too simply as "pure" and "applied" science—research for the advancement of knowledge and research directed towards specified goals. Apart from the truism that all knowledge is good and potentially useful, our ignorance about the natural history of most of the marine game fish species and about the myriad of organisms that affect them is still too vast to warrant direction of the research towards pre-determined applications of the results. Nevertheless, even though we engage in the most immaculately pure research, we must always hold before us our fundamental purpose which is to provide information required to formulate governmental policies regarding conservation issues.

Limitations to Studies of Fish Species

We have set out to fill gaps in knowledge about the natural history of sport fish species. As we have seen, the species are many; and the areas of ignorance about most of them are large. These conditions give us a sense of urgency which impels us to limit ourselves to relatively brief though intensive studies of species. The most important research requirement of these projects is that they each encompass significantly large segments of the species' ranges. For example our study of bluefish, now in progress, extends along the whole Atlantic coast from the Gulf of Maine to the Florida Keys. It includes a tagging program to trace migrations, scale studies for age and rate of growth, morphometric analysis to distinguish populations, spawning seasons, early life history, and experimental and field studies of behavior. It remains to be seen at what point we can resist the temptation to pursue new questions that open up. That point will come when we have accumulated enough information to provide a basis of good judgment concerning conservation issues. Then we must draw this project to a conclusion and take up another species for study. Sport fishermen are eager for all sorts of information about game fishes. They are as fascinated by the humdrum normal life in the sea as much as by the bizarre. However, their most frequent questions concern the vagaries in the occurrence and the abundance of fish, such as these—

"I have always caught stripers in Smithtown Bay in June. This year they didn't show up. Why?"

"I never saw so many bluefish as there were around here in August. Then suddenly they left. What happened? Where did they go?"

"Some years mackerel come in early April, other years not until May. When can we expect them this year?"

We can answer such questions by saying something about "how fluctuations of the environment affect the occurrence of fishes". But this answer can't be very satisfying. What features of the environment are critical in these instances?

Studies of Environment

The most important items are temperature, salinity, ocean currents and abundance of fodder. In order to learn how these factors of the environment relate to the fish species, the essential research requirement is systematic survey over very large distances—the whole Atlantic coast, the Pacific coast, the Gulf of Mexico; from the shore out as far as coastal fishes occur. The observations should be closely spaced in time so that the survey will yield approximately synoptic pictures of the observed parameters. It is inconceivable that any one institution would have the means to conduct such a survey monthly year after year. This becomes quite possible however, if several laboratories were to collaborate, each responsible for a small segment of the coast, all working simultaneously according to an agreed upon design. Such surveys are taking shape on the Atlantic and Gulf coasts under the stimulus of an informal organization of laboratories called the SEAS Committee (Scientific Exploration of the Atlantic Shelf). The most important contribution to large scale synoptic survey has been the use of IRT "Infrared Radiation Thermometer", operated from aircraft. This makes it possible for two men in addition to the airplane crew to cover 11,000 square miles or more in five hours, recording the temperature continuously along the way to an accuracy of 0.2 to 0.5°C. During the operation they also drop drift bottles and bottom drifters at frequent intervals. A third man in the team is useful to watch the sea surface and keep various records regarding the color of the water, the patterns of waves, and the occurrence of surface swimming animals such as whales, sharks, turtles and schools of fishes. A number of laboratories of the United States and Canada are now making periodic surveys with the IRT along several coastal sectors of the Atlantic, Gulf of Mexico and the Pacific. It seems likely that within a few months these sectors will all connect. Meanwhile we must make enough comcommitant surveys with research vessels using conventional hydrographic equipment to learn how accurately we can estimate the sub-surface temperature structure from the IRT surface data.

Mapping the Distribution of Fishes

A satisfactory technique of systematically and synoptically mapping the distribution of fishes has yet to be developed. Fishing from research vessels is too slow and selective. It is desired to locate concentrations of fish, identify the species, estimate roughly the sizes, and map the distribution in relatively quantitative terms. The most promising approach would seem to be a combination of highly sophisticated sonar equipment and either underwater television or windowed submarines. Here again co-operation among several laboratories would be necessary to cover entire distributions synoptically.

Practical Application

It is necessary in planning research to think ahead to eventual applications in conservation action. What might be the nature of this action?

To an old time fishery biologist, the first thing that comes to mind is regulation of fishing rates according to principles of population dynamics. This device is appealing because it is founded on carefully developed theory which has been tested experimentally with laboratory populations. It is a practical device for the big commercial fisheries which provide the supreme advantage of being concentrated in a few ports through which are funnelled practically the entire catch, and thus the fish caught can be sampled to monitor changes in age and size composition. It seems very doubtful that the data required for population dynamics analyses could be anywhere near accurate enough in sport fisheries to justify the cost of collecting it. Remember how dispersed sport fishermen are, how irregular their habits, how small their individual catches, how many species they catch. If the problem of sampling fishermen is difficult, that of sampling their catches is several orders of magnitude more difficult. From a practical point of view, it seems most likely that any regulation of the catch of sport fishermen would have to be based more on well informed judgment than on mathematical calculations.

Habitat Improvement

A more positive approach to conservation of marine sport fish resources is to enlarge fish populations by improving habitats. This is practical in shallow waters along shore and in tidal embayments. Even though most of our coastal fish species range over great distances, they are unevenly distributed. In the course of their migrations, they seem to hurry past rather long stretches of the coast to reach certain areas where they may reside for several months; and even there they concentrate about certain favored spots. These spots are generally characterized by irregularities in the bottom such as ledges, canyons, sharp changes of depth, rocky hills and artificial structures such as pilings, offshore oil rigs and bridge piers.

Several states have taken advantage of this fact by constructing artificial fishing reefs. These are composed of various materials such as old automobile bodies, street-cars, oyster shells and quarry rock. Before long, communities of organisms from minute invertebrates and plants on up through the food web come to inhabit these structures, and thus make fishing grounds where none had existed before.

Floating objects such as rafts, logs and planks attract pelagic fish. Anchored fish-collecting rafts called *tsuke* rafts are used in Japan for this purpose. According to the *Sport Fishing Institute Bulletin* (No. 157, 1964), Japanese biologists are planning to release 300 planks to assess their value in concentrating tuna and other pelagic fishes.

Juvenile fish often associate with drifting objects, including jellyfish. This habit may have important survival value; for they take advantage of the con-

centrations of smaller organisms that also gather about these objects. The objects may afford some protection from predators and since they are generally drifting towards shore, they may help in guiding the young fish to their shallow water destinations.

The habitats for the young of many marine game fish species are in the shallow waters of the coastal zone, especially in estuaries, creeks of marshes, lagoons and channels behind sand barriers. The possibilities for developing special areas in this estuarine zone for cultivating particularly desired species is a wide open subject for research.

Artificial reefs, floating objects and the improvement of estuarine nursery areas all involve intercession in the environment. The principle research need is simply to encourage more and more research in this field, which promises to change our focus in conservation matters from preoccupation with what people shall not do to what they can do.

Conservation of the Estuarine Environment

A direct threat to marine sport fish by overfishing is negligible in comparison with the threat to their estuarine habitat by human activities. It is here that pollution is most damaging to marine life. It damages the health and shortens the life span of useful marine organisms inhabiting these waters. It impairs their palatability; in areas near cities and towns it makes shellfish unsanitary and unsafe for human food. One principal research need concerning pollution is to measure the long range effects on the physiology and fertility of marine organisms, on the viability of the eggs and the development of the the young. For all pollution studies, there is a need to cultivate a standard laboratory test animal, a marine counterpart of the white mouse which will reproduce and prosper in aquaria.

The most serious threat to the estuarine habitat is the filling in of marshes to make new industrial and housing property. Land developers push this process forward relentlessly, often with the virtuous feeling that they are really benefiting the country by reclaiming a wasteland. The most pressing research needs here are less in biology than in humanistic affairs. Regional planners, apprised of the unique natural and recreational values of the estuarine zone should study to find alternate ways of eliminating garbage and alternate locations for new housing developments. Economists should examine the economics of land use, weighing all the actual and potential values in the estuarine zone from which we must choose—the aesthetic values, the recreational values, the value for the production of food and game, the value for the creation of real estate, the value as a dumping ground for refuse.

The multiple use concept of land management should be considered in plans for developing any coastal area. In the U.S. the lack of public access to the sea is an increasing problem near centers of population along our Atlantic coast. Here the cost of acquiring public recreation areas and access rights is increasing rapidly as a result of intensive competition with private interests.

Need for Adequate Support

Apart from the substantive research requirements concerning sport fisheries is the fundamental need of providing a hospitable atmosphere for research. This includes an appreciation of the immensity and importance of the subject. The general public living close to the seashore and marine anglers in particular are intensely interested in the subject. Non-fishermen are likely to think of it, if they think of it at all, as a rather frivolous thing for the government to be doing. If the research is to yield useful results, it must have adequate financial support. The amount of this support should be established according to the size of the job and the economic and social values of sport fishing. The scientists engaged in the program should be a well balanced team competent among them to deal authoritatively with the wide assortment of problems that must be attacked. And they must be allowed a free scope to deal creatively with these problems, independently of the old orthodoxies of fishery research.

Table 1

FIN FISHES YIELDING TO ANGLERS OR TO COMMERCIAL FISHERMEN 10 MILLION POUNDS OR MORE IN 1960, RANKED IN ORDER OF IMPORTANCE

Catch Reported by Anglers. Millions of Pounds		*Catch off U.S. Coasts Commercial Fishermen. Millions of Pounds*	
	Atlantic Coast		
Flounders	53.0	Menhaden	1177.4
Bluefish	50.6	Herring	155.2
Jacks	41.2	Whiting	111.6
Red Drum	38.6	Haddock	100.0
Striped Bass	37.5	Flounders	78.3
Porgies (Scup)	36.6	Alewife	51.0
Sharks	36.2	Porgies (Scup)	49.2
Groupers	34.3	Cod	36.6
Cod	30.9	Ocean Perch	25.0
Black Drum	30.0	Pollock	22.3
Snappers	26.4	Thread Herring	12.4
Sea Trouts	26.9	Butterfish	11.0
Spanish Mackerel	24.8	Spot	10.8
Pollock	21.7		
Tunas	21.4		
Grunts	20.9		
Tautog	20.9		
Kingfishes	18.7		
Tarpon	16.0		
Mullet	15.5		
Black Sea Bass	12.5		
Spearfishes	12.3		
Mackerel	10.9		
Croaker	10.4		
Spot	10.4		
	Gulf of Mexico		
Sea trout	103.8	Menhaden	840.9
Groupers	74.8	Mullet	32.7
Spearfishes	41.8	Red snapper	10.2
Drum, red	32.9		
Jacks	24.2		
Catfishes	22.3		
Croaker	19.0		
Sharks	16.6		
Porgies	12.8		
Drum, black	12.6		
Mackerel, Spanish	11.3		
	Pacific Coast		
Bonito	42.3	Salmon	234.2
Yellowtail	30.8	Herring	83.8
Barracuda	19.9	Jack Mackerel	74.9
Striped Bass	19.8	Sardine	57.5
Cabezon + sculpin	17.6	Halibut	46.3
Flounder	14.4	Flounder	47.7*
Rockfish	13.6	Mackerel	36.8
		Tuna	41.6
		Rockfishes (including ocean perch)	36.1*
		Sablefish	11.3*

* figures include catches off Canada coast.

Table 2

25 ATLANTIC COASTS FIN FISHES YIELDING 10 MILLION POUNDS OR MORE TO ANGLERS: ESTIMATED PERCENTAGE OF TOTAL HARVEST TAKEN BY ANGLERS

	Anglers' Catch	Total Harvest by Anglers and Commercial Fishermen	Percentage of Total Harvest Taken by Anglers
Flounders	53.0	131.3	40.4
Bluefish	50.6	53.3	94.9
Jacks	41.2	41.2	100.0
Red Drum	38.6	38.8	99.5
Striped Bass	37.5	46.1	81.3
Porgies (Scup)	36.6	85.7	42.7
Sharks	36.2	38.2	94.8
Groupers	34.3	34.5	99.4
Cod	30.9	67.5	45.8
Black Drum	30.0	30.3	99.0
Snappers	26.4	27.3	96.7
Sea Trouts	26.9	32.1	83.8
Spanish Mackerel	24.8	27.2	91.2
Pollock	21.7	44.0	49.3
Tunas	21.4	22.8	93.9
Grunts	20.9	20.9	99.8
Tautog	20.9	21.1	99.1
Kingfishes	18.7	22.0	85.0
Tarpon	16.0	16.0	100.0
Mullet	15.5	23.5	66.0
Black Sea Bass	12.5	19.5	64.1
Spearfishes	12.3	12.3	100.0
Mackerel	10.9	13.9	78.4
Croaker	10.4	17.2	60.5
Spot	10.4	21.2	49.1

SOME RESEARCH REQUIREMENTS IN FRESHWATER SPORT FISHING

by

T. G. Northcote

Introduction

The following discussion will be restricted largely to a consideration of biological research required in management of freshwater sport fisheries. Of course, research bearing on physical and chemical aspects of the freshwater environment must be included as well as that pertaining to fish and other organisms of direct or indirect importance to the sport fish species. Also some attention will be given to research in sport *fisheries* and their involvement with that very important biological factor, man himself. Research "requirements" will be examined at two different levels, (1) general requirements for research, i.e. the proper attitude, training and freedom necessary for conducting effective research and (2) more specific areas where research has been neglected or where much more research is required.

There have been several reviews of fishery research needs which considered North American freshwater sport fisheries. At the Seventh Pacific Science Congress held at New Zealand in 1949, K. Radway Allen presented a paper summarizing the types of freshwater fisheries research undertaken in North America up to 1945 (Allen, 1953). A.S. Hazzard discussed the need for research at some length in his opening remarks at the 1951 meeting of the American Fisheries Society and asked the Standing Committee on Hydrobiology and Fish Culture of that Society to prepare a special report on research needs in fisheries (Hazzard, 1952). The subsequent president of the A.F.S., W.J.K. Harkness, again dealt with fisheries research at the 1952 meeting of the Society (Harkness, 1953) where the committee on Hydrobiology and Fish Culture presented its report on fisheries research needs (Moffett, 1953). This same committee dealt with more specific research requirements in its report to the 1953 A.F.S. meeting (Tunnison, 1954). Also at the 1953 meeting, a symposium reviewed the present status, objectives and needs of fishery research in North America (Harkness *et al.,* 1954). The A.F.S. committee on Hydrobiology and Fish Culture again reviewed freshwater fisheries research and reported on research needs in this area (Larkin, 1958). More recently, Benson *et al.,* (1961) has outlined research needs in management of lakes in four major regions of the United States and Canada while Leonard (1963) has considered future research in fisheries.

In addition to the reviews noted above which were largely held in conjunction with meetings of the American Fisheries Society, the meetings of the Cana-

dian Committee on Freshwater Fisheries Research held annually since 1948 in Ottawa have provided an informal review of some Canadian research requirements in freshwater sport fisheries.

In 1952 the C.C.F.F.R. held a symposium on "The Role of Research in Fisheries Management" wherein the several contributors outlined various research requirements for management of freashwater sport fisheries in British Columbia (Larkin, 1952), Alberta (Miller, 1952) and Ontario (Fry, 1952; McCrimmon and Loftus, 1952; Doan, 1952). The U.S. Outdoor Recreation Resources Review Commission (O.R.R.R.C.) published an extensive report which considered general problems of research (Anonymous, 1962a) and the U.S. Bureau of Sport Fisheries and Wildlife, in its report to the O.R.R.R.C. dealt more specifically, although briefly, with research needs in sport fisheries (Anonymous, 1962b). Recently a comprehensive program for management of Michigan's sport fisheries has been prepared indicating a number of areas where more research is required (Anonymous, 1964).

One might conclude then, that there has been ample opportunity for the discussion of research requirements in freshwater sport fisheries and that these needs may be rather obvious at least to some biologists. Nevertheless this symposium provides an unique opportunity to present and discuss problems in freshwater sport fishing research among administrators and economists concerned with natural resource management.

The Objective of Freshwater Sport Fishing Research

Fisheries research, even in freshwater sport fisheries, has usually been conducted with the object of obtaining knowledge required to manage the resource so that a sustained or if possible increased yield could be obtained (Allen, 1953; Harkness *et al.,* 1954). This objective of obtaining a maximum sustained *yield* in terms of weight or numbers of fish from a fishery has developed in large part from the management of commercial fish populations. There are, or should be however, profound differences in the approach to management of sport and commercial fisheries.

The practice of sport fishing is steeped in antiquated and delightfully inefficient methods of capturing fish which have undergone little radical change for centuries. Nor will these methods, like the properly conservative attitude of their proponents, probably change in the near future. If this be the case, and we continue to manage the fisheries of the majority of our inland waters solely or largely for sport fishing, then it may well be a serious mistake to aim at anything near maximum sustained yields. To do so would require an intensity of effort so high that the recreational value of the fishery would become greatly reduced if not negligible. Sport fishing is, after all, a sport and thereby should be an aesthetic experience pursued for the sustained pleasure of man, not the maximum sustained yield of fish flesh.

Furthermore the concept of managing a commercial fishery not towards a maximum sustained yield but towards an optimum yield, usually below the

maximum, apparently has gained approval of both fishery biologists and economists (McKenzie, 1959). Judgments here however are based on maximization of net economic yield, a reasonably tangible and quantitative measure not readily available to sport fisheries. The objectives of sport fishery management and hence in part those of its associated research should recognize that *maximum recreational value* may be obtained from a sport fishery where annual yields in terms of number of fish or weight of fish are well below the maximum sustained yield. Quantification of the recreational value of a sport fishery, however difficult, must be attempted and will probably have to include rather subjective judgments, based upon appraisals of user, i.e. angler, preferences and opinion. Some progress has already been made in this direction (Allen, 1962; McFadden *et al.*, 1964), much of which will undoubtedly be discussed in detail by other panels of this symposium.

Research in freshwater sport fishing then should provide the concepts, techniques and basic information required to permit management of the sport fishery towards realization of its maximum recreational value. Such research must consider not only the existing environment, sport fish and fisheries but also must be particularily cognizant of future trends in each of these three aspects.

General Requirements for Research

A basic requirement for research in freshwater sport fishing is to obtain a suitable *attitude* and *"climate"* in which to conduct it. There has been much discussion of this problem in the recent years and indeed evidence of an "amelioration of the climate" for fisheries research. However, there have been enough periods of "bad weather" for sport fishery research to make the penetrating comments of Moffett (1953) as valid and appropriate today as they were over a decade ago. I take the liberty of quoting them at some length.

> "Many persons, including some fishery administrators, believe or have believed that all troubles in fisheries will disappear immediately when scientists are added to the staff. With this naive faith, it is understandable that their enthusiasm should be transformed to resentment when the administrative miseries persist; that research as an activity should come into bad odor and scientists be regarded as impractical and curious 'fiddlers' undeserving of support; that investigational programs should so often be rendered impotent by lack of support. Surely we need improved understanding by administrators of the true nature of research and by researchers of the urgency of administrative problems.
>
> "The administrator for his part should realize that no basis exists at all for the classification of research as 'practical' or 'academic'. All research that contributes to our knowledge of the way fish live is practical; properly conducted inquiries, on the other hand, are academically sound whether or not they are designed to yield immediately useful results. The administrator must grasp further that it is no more possible in fishery science than in agriculture to plant today and harvest tomorrow. When he makes unreasonable demands for quick appraisals of complex problem situations and comprehensive management programs for waters barely seen, much less studied, he is forcing charlatanism on his staff and inviting discredit on himself.
>
> "Scientists, in their turn, should recognize that the last word need not be said in an inquiry before some use can be made of the results. An investigation that has been properly planned and intelligently executed almost certainly will yield instructive results during its progress. An alert and co-operative researcher will inform himself as to the pressures that

bedevil his administrative superiors and will regularly make available to them any findings that may contribute toward the easing of their problems.

"In short, we need administrators who grasp that scientific facts cannot be ordered up like groceries in a market, that the results from a truly worthwhile research program can seldom be anticipated, much less stipulated and scheduled. We need just as badly scientists who can carry out basic inquiries and at the same time assist administrators in their problems without stooping to superficiality...

"In our general approach to a fishery problem we exhibit a passion for *doing*, for *physical activity* and a revulsion at the mental drudgery and physical inactivity that inevitably go with the analyses. As a result we accomplish little real research. All of us recall instances where support for a program was forthcoming as long as it was an *action* program. But as soon as deliberation and treatment of data required long hours of physical *inaction*, the data were left untouched, and the persons reassigned to another *action* program. The researcher had only his personal impressions to offer as the result of all the field work. These impressions were always qualified and nebulous. Under such circumstances, the administrator is forced to conclude that research is expensive, yields nothing but vague opinions and merits no further consideration as a part of his *action* program."

In addition to development of the proper attitude for research among the public, the administrators, and the biologists themselves, as pointed out in the comments of Moffett (1953) above, there remains the problem of who should be responsible for conducting research in freshwater sport fishing and where this should be done. Although much of the basic research of pertinence to freshwater sport fishing has traditionally been conducted at universities, most provincial government agencies concerned have now either formed their own research groups or have encouraged university participation in specific problems requiring basic research (Larkin, 1958). Where separate research groups are established, it is essential that they be given considerable freedom to develop and conduct research programs which are not solely directed to solving the management problems of the moment. There are many advantages in having such research groups closely associated with universities active in fisheries and ecological research.

Trends in Freshwater Sport Fishing Research

Before discussing specific requirements for research, it would be of value to consider briefly the changes which have taken place in major types of freshwater sport fishery research throughout its recent period of development in North America. Fortunately Allen (1953) has documented these changes up to 1945 based on an analysis of papers published in the Transactions of the American Fisheries Society. He recognized several main categories of research including (1) general biology—feeding habits, growth studies, migration and spawning habits, (2) improvement of methods—hatchery and liberation techniques, cause and control of hatchery diseases, general descriptive methodology, (3) critical studies—quantitative evaluation of existing and potential management practices, (4) other quantitative studies—size and age composition of wild populations, measures of fishing intensity and yield, (5) effect of human activities—beneficial and deleterious modifications of habitat, (6) local problems and surveys, (7) unclassified. Although there was difficulty in categorizing some papers under these headings, the majority could be classified without much deliberation. My classification of papers between 1941 and 1945 agreed reasonably well with that of Allen's, although I would have made the percentage of human activity effects slightly higher.

The results of Allen's analysis to 1945 (with categories 6 and 7 combined) and my analysis from 1946 to 1964 are presented in Table I. Since 1930 between ¼ and ⅓ of all papers published in T.A.F.S. have dealt with some aspects of general biology, either of fish or their environment. Allen (1953) noted the dominance of growth studies in general biological research, probably caused by the almost ritualistic practice of scale sampling, characteristic of most fishery studies. Although there appeared to be less preoccupation with scales and aging in recent years, still nearly 30% of general biological papers in T.A.F.S. since 1961 have dealt almost solely with this aspect of fish biology. The gradual decline in the contribution of methodology papers evident up to 1945 has levelled out to slightly less than ¼ of the total for most recent periods. However, since 1959 many papers in techniques were not included in the analysis as they appeared in the short papers and notes section of T.A.F.S. Trends in categories 3 and 4 are of particular significance. The marked increase in the so-called "critical studies" evident up to 1945 has not continued, and indeed has slightly declined since 1950. Other quantitative studies, largely documenting vital statistics of particular fish populations, continued to increase slowly at least until 1955. The somewhat surprising decline up to 1945 in the proportion of papers dealing with the effect of human activities (according to Allen a result of waning of early interest in habitat improvement) apparently has been reversed with a growing number of publications on effects of impoundments and pollution.

Table I. Categorization (by percentage) of papers published in the Transactions of the American Fisheries Society between 1926 and 1964.[1]

Research Category	1926-30	1931-35	1936-40	1941-45	1946-50	1951-55	1956-60	1961-64
1. General Biology	18.5	30.9	35.8	24.8	25.9	34.4	31.2	33.1
2. Improvement of Methods	54.3	36.3	28.3	19.6	21.4	18.5	26.2	14.8
3. Critical Studies	2.2	1.8	6.8	16.3	14.3	11.8	8.8	11.0
4. Other Quantitative Studies	0	6.5	11.5	12.8	17.0	18.5	7.5	13.9
5. Effect of Human Activities	8.7	4.2	1.4	0.9	5.4	4.2	7.5	14.5
6. Local Problems, Surveys & Unclassified	16.3	20.3	16.2	25.6	16.0	12.6	18.8	12.7

[1] Data for 1926-1945 from Allen (1953)

In general, there would appear to be no lack of fisheries research publications dealing with descriptive life history information or with methodology. What seems to be needed are more contributions of a critical, quantitative and experimental nature. Indeed the fact that publications in this category reached their highest percentage (1941-45) when general biology and methodology papers were low, may not be coincidental.

More Specific Requirements in Freshwater Sport Fishing Research

Although several aspects of research in freshwater sport fishing will now be considered, the treatment will be to comment generally on a few outstanding research needs in these areas, rather than to suggest in detail a long series of specific requirements with perhaps restricted or local application.

1. The Environment

There can be no question that demands on the freshwater environment, both for recreational and non-recreational uses are going to increase greatly in the next few decades (Anon. 1962b). Although Canada is well endowed with inland waters, utilization is already becoming excessively heavy at least near areas of high population. In addition to continuing research on the limnology of lakes, there is need for much more intensive study of rivers and streams. Lakes, being at least semi-closed units of environment, are in many ways easier to study, particularly for factors controlling energy flow and productivity. On the other hand the open systems of flowing waters are not only more difficult to treat experimentally, but also are subject to more rapid and extensive change by man's activities. For this latter reason alone increased research on their limnology is urgently required.

Other neglected types of freshwater habitat needing more research include alpine lakes, moderately saline lakes and ponds. When a greater understanding of all aspects of their limnology is obtained, better management of species suited to these special environments may be possible.

Although the number of reservoirs and impoundments in Canada continues to grow annually, there has been little concerted effort to study in detail the accompanying changes in their physical-chemical limnology or biological productivity. To be sure there have been sporadic studies in some areas such as Alberta (Nursall, 1952) and British Columbia (McMynn and Larkin, 1953) but nowhere in Canada has reservoir limnology been attacked with the comprehensiveness shown in Czechoslovakia (Stepanek and Votavova, 1962) or in Sweden (Rodhe, 1964; Runnstrom, 1964; Nilsson, 1964). The European work on reservoirs can be used to suggest general effects of impoundments on Canadian lakes and rivers, but differences in character of the lakes and rivers and their fisheries before alteration as well as differences in water level change and fluctuation thereafter make it imperative to conduct more extensive studies here. Although many of the effects of reservoirs (as commonly regulated) are detrimental to sport fishes, it may well be possible to construct and control reservoirs specifically for the benefit of sport fishes and the enhancement of sport fisheries.

Winter limnology is another area requiring further research to provide basic knowledge of environmental conditions important to sport fishing. Several of our most productive sport fishing lakes in British Columbia are periodically subject to severe if not complete overwinter mortality of trout. In at least one case the winter-kill problem was associated with incomplete autumnal circulation. A research program on the winter limnology of this small, eutrophic lake led to the development of a management technique using artificial aeration restricted to a brief period prior to freeze-up of the lake. This technique has proved most successful in preventing a specific type of winter-kill in British Columbia but it is no panacea to the problem. Further work is required on winter conditions in a variety of lakes, pond and stream types.

It is now becoming feasible to manage environmental conditions in lakes as well as streams. Water levels and fluctuations may be controlled, as can circulation and evaporation rates in small lakes. We are approaching the time when it may be possible to modify thermal stratification, dissolved gas and nutrient content as well as other important environmental features of small lakes. Research is needed to develop and evaluate effects of environmental control in lakes and streams on production of sport fish.

A great deal of recent work in freshwater ecology has centered around the study of productivity, especially at the primary level using radioisotope techniques. While the significance of these studies to sport fish production cannot be overemphasized, there has been a tendency to concentrate on production at the primary level. In some cases, particularly where cyanophytes are dominant, a smaller than usual portion of primary production may be passed on to higher trophic levels. Efficiency of energy transfer from primary to secondary levels should be studied in different combinations of algal groups and sizes. The importance of some trace elements to primary production has been indicated by studies of Goldman (1960, 1964). More research is needed not only on microconstituents which may act as growth promotors but also others which may act in low concentration as inhibitors of growth and production. Finally the effects of industrial pollution and cultural development on the productivity of lakes and streams requires more intensive, co-ordinated research. Studies in this direction are being conducted on the Great Lakes but they are needed in other Canadian waters, both large and small.

2. *The Sport Fishes*

(a) *Life history, general biology, behaviour.*

Despite the fact that the preponderance of research on freshwater sport fishes has been and continues to be directed towards general life history studies, there still is a surprising lack of knowledge on the biology of many species. Little is known of lacustrine populations of rainbow trout from the time they enter a lake until they enter the fishery. Similarly juvenile stages of most sport species and all stages of important competitor or predator species of fish require additional study. Basic life history studies are still needed for some of the less utilized sport fishes such as cutthroat trout, Dolly Varden, kokanee, mountain whitefish and Arctic grayling. These species as well as others now regarded as undesirable (for example, cyprinids such as squawfish and peamouth chub) may become important as sport fish in the future.

Differences in behaviour between races of a single species should be investigated. For example the migratory behaviour of some juvenile rainbow trout populations appears to be controlled in large part by environmental conditions in streams tributary to lakes (Northcote, 1962). However, for populations inhabiting cool, headwater streams a quite different mechanism may regulate their responses to water current. Behavioural approaches to study of competition

between juvenile sport fish, such as those of Hartman (1963, MS) should be attempted in other species.

(b) *Physiological studies.*

Research on the physiology of freshwater sport fish has delimited thermal, oxygen and other requirements of a few species, particularly brook trout, over a reasonable range. This approach as developed by Fry (1947, 1958, 1960), Brett (1956, 1958, 1960), and others should be applied to a wider range of species. In addition, more attention could be given to the physiology of fish under winter conditions. Oxygen requirements of few, if any species, are known below 5°C.

(c) *Population dynamics.*

Most sport fish stocks are "managed" with an almost ludicrous lack of knowledge of their population dynamics, especially when compared to the information available and used in management of many commercial species. In part this situation arises from the fact that freshwater sport fish stocks are broken up into such a large number of discrete units, many of which may require specific attention. Thus in British Columbia absolutely no information is available for 81% of a total of at least 22,000 lakes in the province, and less than ¼ of about 2000 lakes known to contain sport fish receive any management whatsoever even of the crudest form (Northcote, 1964). What is required at this stage is enough basic research on both lakes and streams and on their sport fish populations to permit broad types to be recognized. Following this, intensive study of examples of each type should yield enough information to start true management of the sport fish populations and fisheries in most of the waters. Monitoring populations in representative types would be continued to evaluate effectiveness of management and additional research should attempt refinement of the categories distinguished.

3. The Sport Fisheries

A prime requirement for management of a sport fishery is to measure quickly and efficiently the effect of that fishery on the population being exploited. To do so will become increasingly important as changes in location and intensity of fishing effort become more rapid and pronounced, a result of greatly increased number and mobility of anglers. Furthermore the effect of higher fishing pressure should be evaluated on species and habitats now subjected to only moderate or low intensity of effort. Some such as Dolly Varden or lake trout in unproductive streams or lakes may be highly vulnerable to severe angling pressure, while other species such as the brown trout may be much more resistant. Quantitative, critical study of fishing effort and its effects on different populations will suggest means of manipulating effort by regulation or otherwise so that the best utilization can be made of available sport fishes and habitat. In addition introduction of resistant species or creation of new habitat types may be required.

In order to properly manage a sport fishery, further research is required to develop methods, as quantitative as possible, for measuring present fishing preferences for species, size and number of fish, type of water, angling method

and so on. Of course sport fisheries must be regulated so that maximum sustained yields are not exceeded, except in some special cases. Fishing preferences can be expected to change, in part a result of the gradual evolution of a more sophisticated angling population. Some recognition, where possible, should be given to minority preferences as well as those of the majority.

4. The Management Practices

Sport fishing management should attempt to purposefully manipulate both the sport fish population and its fishery towards obtaining the maximum sustained *recreational* value from the resource. With that object in mind the need to evaluate the effectiveness of existing management practices and to test potential new methods should be clear. (Evaluation of existing practices and immediate development of new management techniques should not become a dominant part of a freshwater sport fishery research program. Continued emphasis must be placed upon the more general and basic research even though it may often show little relevance to the administrators' pressing problem of the day. Such research will inevitably shape the management concepts and programs of future decades.)

Strong selection is made *in the hatchery* for stocks exhibiting rapid growth rate (on hatchery diets), low mortality, resistance to disease, etc. Although some research has been conducted on the "follow-through" of these hatchery advantages after stocking (Miller, 1954; 1958; Flick and Webster, 1964), these need extension and investigation in other sport fish. Apart from ability *to survive* in the wild situation, the fighting ability and edibility of hatchery reared fish should be compared with the wild forms. At least one study suggested that hatchery reared brook trout may have an inferior taste in comparison with wild stocks (Beader and Tack, 1945).

Manipulation of fish populations has usually been accomplished by complete eradication with toxicants and then restocking. At best this practice has only been partially successful and in most cases only temporarily effective. A partial kill or reintroduction of undesirable species has been the usual result, and then after the fishery has been eliminated for a one- to two-year period at least. The merits of a manipulation program based largely on eradication and restocking needs critical evaluation. More subtle but at least as effective a means of manipulation may be found in other techniques such as control of spawning success or use of sterile hybrids.

There has been a marked practice in the last decade to remove all restrictive angling regulations which had no biological origin or value in the management of sport fisheries. This, of course, is as it should be. However, as management becomes more intensive and its techniques more varied and effective there will probably be a return to more localized, specific regulation. Indeed if attempts are made to improve the *quality* of sport fishing based on at least a quasiquantitative appraisal of angler preferences, some particularily severe size limits, gear restrictions and attention to particular species may be required locally.

A General Comment

The quality of sport fishing in Canada has been regarded very highly throughout North America and abroad. This regard has been quite justified and probably will continue to be so for the next few decades at least. However, these high quality sport fisheries have been largely based on two factors, both of which will diminish if not disappear by the turn of the century. The first factor is the low intensity of effort to which most of our sport fisheries have been subjected. Although all provinces have experienced a spectacular rise in the number of both resident and non-resident anglers since the end of World War II, this increase has not reached levels comparable to those in the eastern states of the U.S.A. or in California. There can be no doubt that it will. The second, and perhaps more important factor accounting for high quality fishing in Canada is that it is based heavily upon "frontier fishing". The well-informed or endowed fishermen, and many fishery biologists and administrators themselves will usually head for that "back-country" lake or stream where access is limited or difficult in order to obtain high quality fishing. This behaviour may be in part due to the wish to commune with the wilderness, but I suspect that the prospects of a good catch of large fish is often the prime motive. By and large in Canada we haven't been required, *as yet,* to conduct any true management of our sport fisheries or to develop the necessary research to support and guide such management. But the time is rapidly approaching when we will have to do so if we are to retain our distinction as an area renowned for high quality sport fishing.

Summary and Conclusions

1. The objectives of sport fishery management and its supporting research should give more consideration to obtaining maximum sustained recreational value from the resource and less to maximum sustained yields of fish, a concept more appropriate to commercial fishery management and research.
2. Some improvement in attitudes and climate for research are still required on the part of sport fish administrators, managers *and* research personnel.
3. There is adequate emphasis on descriptive life history investigation but a lack of critical, experimental research, particularly on population dynamics of sport fishes.
4. Attempts to measure and quantify sport fishing *quality* are required if the more general objectives of *sport* fishery management are to be fulfilled.
5. More *true* management in the sense of *purposeful manipulation* and *control* of sport fish environments, populations and fisheries will be required if the distinctive, high quality sport fishing is to be maintained in Canada. Such management will place far greater demands on sport fishery research and necessitate intensified and broadened research programs.

Acknowledgments

The comments and criticism of Dr. G.F. Hartman, Dr. J.T. McFadden, Dr. C.C. Lindsey and Dr. N.J. Wilimovsky are sincerely appreciated.

REFERENCES

ALLEN, K. R. 1953. *The objects of fresh-water fisheries research.* Proc. 7th Pac. Sci. Cong., 4:556-562.

———— 1962. *Exploitation of fish populations.* New Zealand Ecol. Soc., 9:39-43.

ANONYMOUS. 1962a. *Outdoor recreation for America.* The report of the Outdoor Recreation Resources Review Commission to the President and the Congress. U.S. Govt. Printing Office, Wash. 25, D.C., 246 pp.

———— 1962b. *Sport fishing—today and tomorrow.* ORRC Study Report 7, U.S. Govt. Printing Office, Wash. 25, D.C., 127 pp.

———— 1964. *A management program for Michigan's fisheries.* Michigan Dept. Conservation Publ., 85 pp.

BAEDER, H. A. and P. I. TACK. 1945. *A comparison of the palatability of hatchery-reared and wild brook trout.* Trans. Am. Fisheries Soc., 75:181-185.

BENSON, N. G., J. R. GREELEY, M. I. HUISH and J. H. KUEHN. 1961. *Status of management of natural lakes.* Trans. Am. Fisheries Soc., 90: 218-224.

BRETT, J. R. 1956. *Some principles in the thermal requirements of fishes.* Quart. Rev. Biol., 31:75-87.

———— 1958. *Implications and assessments of environmental stress,* pp. 69-83. In P. A. Larkin (ed.), The Investigation of Fish-Power Problems. H. R. MacMillan Lectures in Fisheries, Univ. British Columbia.

———— 1960. *Thermal requirements of fish—three decades of study, 1940-1970.* Trans. Second Seminar on Biological Problems in Water Pollution, U.S. Public Health Serv., Cincinnati, Ohio, 8 pp.

DOAN, K. H. 1952. *Future prospects for valuable development in this field.* Canadian Fish Cult., 12:26-30.

FLICK, W. A. and D. A. WEBSTER. 1964. *Comparative first year survival and production in wild and domestic strains of brook trout, Salvelinus fontinalis.* Trans. Am. Fisheries Soc., 93:58-69.

FRY, F. E. J. 1947. *Effects of the environment on animal activity.* Univ. Toronto Studies Biol. Ser. No. 55. Publ. Ontario Fisheries Research Lab., 68, 62 pp.

———— 1952. *The role of research in fisheries management in Ontario from the research point of view.* Canadian Fish Cult., 12:20-21.

———— 1958. *Approaches to the measurement of performance in fish,* p. 93-97. In P. A. Larkin (ed.), The Investigation of Fish-Power Problems. H. R. MacMillan Lectures in Fisheries. Univ. British Columbia.

———— 1960. *The oxygen requirements of fish.* Trans. Second Seminar on Biological Problems in Water Pollution, U.S. Public Health Serv., Cincinnati, Ohio, 4 pp.

GOLDMAN, C. R. 1960. *Molybdenum as a factor limiting primary productivity in Castle Lake, California,* Science, 132:1016-1017.

———— 1964. *Primary productivity and micro-nutrient limiting factors in some North American and New Zealand lakes.* Verh. Int. Ver. Limnol., 15:365-374.

HARKNESS, W. J. K. 1953. *Opening remarks of the president.* Trans. Am. Fisheries Soc., 82:294-295.

HARKNESS, W. J. K., J. W. LEONARD and P. R. NEEDHAM. 1954. *Fishery Research at mid-century.* Trans. Am. Fisheries Soc., 83:212-216.

HARTMAN, G. F. 1963. *Observations on behaviour of juvenile brown trout in a stream aquarium during winter and spring.* J. Fish. Res. Bd. Canada, 20:769-787.

———— MS. *The role of behaviour in the ecology and interaction of underyearling coho salmon and steelhead trout (Oncorhynchus kisutch and Salmon gairdneri).*

HAZZARD, A. S. 1952. *The need for research as an aid to better fishing.* Trans. Am. Fisheries Soc., 81:294-297.

LARKIN, P. A. 1952. *The role of research in management of freshwater fisheries in British Columbia.* Canadian Fish Cult., 12:10-12.

———— 1958. *Report of the Standing Committee on hydrobiology and fish culture.* Trans. Am. Fisheries Soc., 87:430-432.

LEONARD, J. W. 1963. *Fisheries for the future.* Trans. Am. Fisheries Soc., 92:74-78.

MCCRIMMON, H. R. and K. H. LOFTUS, 1952. *The role of research in fisheries management in Ontario from the management point of view.* Canadian Fish Cult., 12:22-25.

MCFADDEN, J. T., J. R. RYCKMAN and G. P. COOPER. 1964. *A survey of some opinions of Michigan sport fishermen.* Trans. Am. Fisheries Soc., 93:183-193.

MACKENZIE, W. C. 1959. *Biology and economics in fishery management.* Proc. of conference on "Biological and economic aspects of fisheries management", Univ. Wash; 1959, pp. 17-21.

MCMYNN, R. G. and P. A. LARKIN. 1953. *The effects on fisheries of present and future water utilization in the Campbell River drainage area.* British Columbia Game Comm., Mgmt. Publ. No. 2, 61 pp.

MILLER, R. B. 1952. *The role of research in fisheries management in the prairie provinces.* Canadian Fish Cult., 12:13-19.

———— 1954. *Comparative survival of wild and hatchery-reared cutthroat trout in a stream.* Trans. Am. Fisheries Soc., 83:120-130.

———— 1958. *The role of competition in the mortality of hatchery trout.* J. Fish. Res. Bd., Canada, 15:27-45.

MOFFET, J. W. 1953. *Report of the Standing Committees on hydrobiology and fish culture.* Am. Fisheries Soc.,82:315-320.

NILSSON, N. 1964. *Effects of impoundment on the feeding habits of brown trout and char in Lake Ransaren (Swedish Lappland).* Verh Int. Ver. Limnol., 15:444-452.

NORTHCOTE, T. G. 1962. *Migratory behaviour of juvenile rainbow trout, Salmo gairdneri, in outlet streams of Loon Lake, British Columbia.* J. Fish. Res. Bd. Canada, 19:201-270.

———— 1964. *An inventory and evaluation of the lakes of British Columbia with special reference to sport fish production.* Trans. Fifteenth British Columbia Natural Resources Conf., 575-582.

NURSALL, J. R. 1952. *The early development of a bottom fauna in a new power reservoir in the Rocky Mountains of Alberta.* Canadian J. Zool., 30:387-409.

RODHE, W. 1964. *Effects of impoundment on water chemistry and plankton in Lake Ransaren (Swedish Lappland).* Verh. Int. Ver. Limnol., 15:437-443.

RUNNSTRÖM, S. 1964. *Effects of impoundment on the growth of salmo trutta and Salvelinus alpinus in Lake Ransaren (Swedish Lappland).* Verh. Int. Ver. Limnol., 15:453-461.

STEPÁNEK, M. and M. VOTAVOVÂ. 1962. *Limnological study of the Reservoir Sedlice near Zeliv, XXI. Numerical characteristics of the horizontal distribution of phytonannoplankton at individual sections of the reservoir and an attempt to determine the total standing crop weight in the intakes and the outflow of the reservoir.* Scientific papers from Inst. Chem. Tech., Prague, Tech, of Water 6, Part 2, pp. 279-344.

TUNNISON, A. V. 1954. *Report of the standing committee on hydrobiology and fish culture.* Trans. Am. Fisheries Soc., 83:387-394.

ECONOMIC ASPECTS OF SPORT FISHING: RESEARCH REQUIREMENTS

by

N. H. Morse

Three areas or problems which merit further thought or clarification and research from the point of view of economics include:

(1) conceptual or definitional matters concerning the good or activity which is the subject of discussion by this Symposium;
(2) conceptual matters and matters of measurement relating to the supply of the good;
(3) conceptual matters and matters of measurement relating to the demand for the good as revealed by sport fishing activity.

I. There is the conceptual or definitional problem of clarifying the good or the scope of the activity with which we are concerned. Sport fishing is the activity and is based, among other things, on sport fishing resources. Sport fishing resources are a complex good or goods comprising, I should think, both fish and habitat. Fish cannot exist apart from habitat while habitat without fish would not constitute a sport fishing resource although it could be a potential resource. Actual resources, comprising both fish and habitat, obviously do not constitute a homogeneous or standardized commodity, like units of a metal. Nevertheless, to think of the resource in terms broader than simply of fish has certain advantages.

II. From the point of view of economics, a number of questions arise concerning the supply of sport fishing resources. It is possible, of course, to consider the supply of sport fishing resources in the absolute sense, and to refer to them in terms of the number of streams, rivers, and lakes, with given stocks or runs of fish. This view looks upon the resources in purely quantitative terms. If we had a unit of measurement, we could designate the quantity of resources on a scale. But some rivers and lakes with their fish populations are more accessible than others. An economic approach would rate the less accessible of two otherwise identical streams as being less significant than the more accessible one. On this basis, the quantity of resources measured on the scale would not be objectively determined by their physical amounts solely but by additional or other factors, some of them subjective. And the quantity of resources would have different value on the scale in the two cases, the latter being below the former.

Let us assume that the quantity of sport fishing resources is a function of the quantity of fish of given species, and the characteristics and location of the habitat. If this is accepted, the quantity of resources can be increased in any or all

of three ways (within limits), namely, by increasing or restoring fish populations, say by methods of fish culture, by the improvement of rivers, streams or lakes, which in turn may affect fish populations as well as improve sites for fishing, and by increasing the accessibility of the distant locations, say by improved transportation facilities.

If we had a unit comparable to tons or feet, by which to measure the resource, the effect of a program which altered any or all of the three variables listed above could be shown. It is probably impossible to devise such a unit. Nevertheless, it is meaningful economically to say that the sport fishing resources can be increased by any one of the three methods.

If we knew the cost of alternative programs, say, of fish culture, and/or stream improvement and/or improved transportation, etc., and the effect of each upon the quantity of the resource we could determine the least cost method of development (regionally) and could calculate or estimate the supply curve, which could be shown by a graph having the quantity of resource measured on the horizontal axis and average cost on the vertical axis. Presumably the function would be an upward sloping function. This function would represent the long run supply curve.

We cannot now draw such a supply curve showing the long run supply of sport fishing resources. Until we can draw one, a range of economic problems defies or eludes economic analysis. All we can do now is to conduct exercises to compare the cost of a highway to Labrador, for example, to make the salmon runs in Labrador's rivers more accessible with the cost of an expanded fish culture program combined with stream improvement and control of pollution in rivers and streams geographically less distant from population and already served by highway systems. If the State has only a certain amount of money to spend, normally it will select the less expensive of two programs unless other factors including multipurpose use are to be considered. It appears that we spend our money without knowing precisely what we get in return in quantitative terms.

This method of conducting our affairs may be all that we can hope to achieve and it may be good enough. To seek to achieve more sophisticated analysis may be to pursue a will-o'-the-wisp or to drag red herrings across the scene. Justification of a road to Labrador could be made in terms of its impact on economic activity through time. Some estimate of these magnitudes would be possible without ever knowing the quantitative effect of the highway on the supply of sport fishing or other resources. But this shifts the focus of interest away from the subject of this symposium to the economics of highway construction and the multi-purpose use of highways.

So long as we stay with our subject, I submit that there is merit in attempting: (a) to clarify conceptually the good we are discussing; and (b) to consider ways of calculating the supply curve of it. If different combinations of fish and habitat cannot be considered as a homogeneous good, then there are many goods comprising the total sport fishing resources, and each good would have its supply curve. Unless there are units to measure supply, we cannot draw a supply curve. Without a supply curve we cannot indicate the effects of developmental expen-

ditures on the size of the resource. The expenditures must then be justified in part on other grounds, that is, on grounds of their general impact on the economy, including the response of sport fishermen in terms of the expenditures they themselves make.

III. A wide range of questions remains in connection with demand. Demand for sport fishing resources is revealed in sport fishing which is the activity. The goods and services demanded by sport fishermen for sport fishing comprise much more than a demand for the use of sport fishing resources themselves. Thus the economic aspects of sport fishing permeate into the economy directly in several directions. A noticeable feature of the situation is that the fisherman generally pays market prices for the goods and services demanded in the course of sport fishing but that frequently the sport fishing resources which are basic to the whole activity are, when under the control of the State, made available under conditions that are virtually free. The implications of this from the point of view of economics are that analysis of the demand for sport fishing resources is out of the question in the usual sense of the term.

It is possible, of course, to obtain information about the utilization of sport fishing resources in real terms such as in rod-days, number of fishermen, and so forth. But this information falls short of that necessary for the analysis of demand which at least involves magnitudes expressed in money terms. Nevertheless, it is helpful to know even in real terms the current and prospective utilization of sport fishing resources. This information can be obtained through (periodic) surveys of sport fishermen in order to ascertain the characteristics of sport fishermen as to age, etc., the pattern of fishing, and to make projections of possible future levels of sport fishing activity based perhaps on projections of population and on other data such as recreation patterns and so forth. There is a great deal of information of this nature that could be collected. Such data are pertinent, especially in virtue of the predictions both of population increase on this continent during the next half century and of expectations regarding the way of life of North Americans.

In order to estimate the demand for sport fishing resources along usual lines, there would have to be greater resort to the pricing system with respect to the use of the resources themselves than now generally pertains. In other words, it might be possible to estimate the demand for sport fishing by experimentally setting prices for the use of the resources by fishermen in order to obtain an indication of the relationship between utilization, expressed perhaps in rod-days, and the price per unit. We do not now have information of this sort but rather that pertaining to the expenditures of anglers in connection with the total sport fishing activity.

Expenditures obviously are a manifestation of demand. The quantity of sport fishing resources demanded (or the utilization of sport fishing resources) is a variable and it would be interesting to know the significance of the different factors determining the demand curve. Demand is a function of the tastes or preferences of individuals. Given the preferences of fishermen, demand will, other

things unchanged, be the greater the lower the prices of the complementary goods consumed in sport fishing and the greater the higher price of substitute activities such as, for example, golf. Analysis of these interrelationships would be useful. Furthermore it may be possible to assess the importance of catch as a factor influencing demand. However, care must be exercised here so as not to confuse analysis of supply with that of demand.

The theory of demand allows for differences in the situations surrounding different individuals by taking into account differences in tastes (e.g. eagerness to fish), incomes, the expectations of individuals, the set of prices prevailing, and so forth. Given the structure of tastes or preferences of individuals, the distribution of incomes, and the set of prices, individuals are assumed to spend their incomes in such a way as to maximize satisfactions subject to the various relevant constraints. This type of analysis is a basic part of the static theory of demand and it is discussed in economics under the general topic of the equilibrium of the consumer or of the household.

It is significant, however, that owing to the inevitable lack of precision which arises in measuring satisfactions and in making interpersonal comparisons we do not know the total level of satisfaction achieved when individuals have reached the equilibrium position. In simple terms, all that the theory states is that when the last dollar spent in any direction purchases the same amount of satisfaction as a dollar spent in any other direction, total satisfaction is maximized. Or, in Marshall's[2] frame of reference, given the price of the unit of activity, say the cost of a rod-day, the price becomes the marginal demand price of the last unit bought.

This analysis is relevant to a study of expenditures of sport fishermen on sport fishing. Presumably, for the individual, if the rate of sport fishing is increased within a given time period, that is, if the rate of consumption is increased, then, *ceteris paribus,* the marginal satisfaction for each additional rod-day eventually will diminish. Given the necessary outlays of money per rod-day, the marginal demand price of sport fishing will be reached and anglers will choose not to consume more recreation in this form. The point beyond which anglers will not devote more of their (time and) money to angling will determine, under given conditions, the upper limit of aggregate expenditures on sport fishing. We can obtain an estimate of total expenditures, therefore, without knowing either the demand curve or the level of total satisfactions derived from sport fishing even though the theory indicates that total satisfaction afforded by the general consumption pattern of anglers would be maximized. We can deduce further that if a unit of sport fishing should fall in price (or in cost) as a consequence, for example, of a reduction in the price of any or all of the goods and services used by sport fishermen, there would be, *ceteris paribus,* an improvement in welfare of sport fishermen. However, total expenditures on sport fishing might rise or fall or remain unchanged depending upon the nature (elasticity) of demand for sport fishing.

In summary, if research were to be directed toward an inquiry into the nature of the demand for sport fishing, relevant topics would include a study of the characteristics of sport fishermen. And if statistical information could be

gathered on the basis of price, progress perhaps could be made on the measurement of demand and of the statistical significance of factors affecting demand such as (changes in) the prices of complementary goods and of substitute activities.

IV. If it is impossible to develop criteria that would enable us to obtain the supply (curves) of sport fishing resources and the demand (curves) for sport fishing in order to indicate equilibrium, it may be possible to make progress in other directions by means of research which would seek to measure the profitableness of moneys spent to improve sport fishing resources. Problems of this type sometimes are formulated within the context of benefit-cost analysis. There are, I think, two levels of abstraction, the first falling short of benefit-cost analysis. What I have in mind here is something like the theory of the firm based on marginal analysis or even the mathematical programming theory according to which the optimum levels of expenditure can be deduced.

If marginal cost is equivalent to the rate of change in total outlay, say, on the part of the State to provide sport fishing resources, and marginal revenue is equivalent to the rate of change of total expenditures of sport fishermen on sport fishing, the provision of sport fishing resources as an enterprise could be carried forward until these two rates of change are equalized in the manner of the theory of the firm. A problem which arises in connection with this approach is that if the use of sport fishing resources is not subject to a pricing system, the State will tend to be only partially compensated. It would receive some returns via taxes and fees in the first round of payments by sport fishermen and subsequently through multiplier effects, but unless some system of pricing is adopted the provision of sport fishing resources might always be in deficit.

However, even if we could determine the profitableness or productivity of moneys spent to increase the supply of sport fishing resources, we still would not know whether it would be the best type of expenditure without making comparisons with a wide range of alternatives along lines of benefit-cost analysis. Here, a number of problems arise. One is that the range of choices may be so broad that, if we are meticulously careful, we may all be dead before we reach a decision. Second, is it not probable that the more a resource has run down the smaller the likelihood that benefit-cost analysis would produce a favourable answer since the potentialities of the resource are increasingly difficult to estimate? Third, with reference to benefit-cost analysis, I am to some extent unsure about the meaning of the concept or term "benefits."

The *Guide to Benefit-Cost Analysis*(3) implies at one stage that benefits are external to man. Benefits are said to be "advantageous effects" representing "real values", and are "akin to total output." On the other hand, primary or direct benefits are the "gains which accrue to those people who make use of the goods and services which can be provided by a given project or program. Theoretically, the real value (monetary measure) of these primary or direct benefits is the maximum amount of money (total outlay?) which consumers are prepared to pay for them." (p.5) Benefits, therefore, are related to expenditures. Yet the expenditure method of estimating the "value" of a resource is said to measure "only the expenditure which

people make to enjoy the benefit. It cannot really measure the benefit itself." (p.29) Or again, "it should be stressed that fishing expenditures are not a fair reflection of enjoyment." (p.27) "Benefits" seem to refer, therefore, to things, e.g., output, and to satisfactions, and to outlays or expenditures. If we cannot measure satisfactions cardinally and have difficulties with the concept "consumers' surplus", it seems we should stress outlays, or similar data that are objective. If we are not too restrictive in our concept of the "good" with which we are concerned, the expenditures approach may warrant a higher appraisal than it seems the *Guide* is prepared to extend to it.

My conceptual difficulties may seem puerile to many participating in this symposium, yet it is because of them that I offer fewer suggestions about possible lines of economic research than others probably could make. However, if we are to reach economic decisions, analysis should be based on data similar to that provided by the market. In virtue of the gradual depletion of sport fishing resources, as for example those for Atlantic salmon, and their limitation or restriction more and more to rivers in the less densely populated areas of north-eastern North America, the situation may arise when it even would be feasible economically to sustain the resource by artificial means in given rivers at least. If this should eventuate, such a program would involve, I should think, the granting of more scope to the pricing system than is true at present both to finance the cost of supplying the resource and to ration its use. The pricing system could be applied in a number of ways—the details need not be discussed here. The analysis would have to take into consideration multi-purpose use of river systems as well as alternative ways of harvesting the fishery resources, e.g., commercially with nets or as sport by angling. Biologists and engineers could provide much information that would be data to economists.

Changed institutional arrangements may be desirable also. Canada is a federation and jurisdiction over fishery resources does not follow a common pattern from one Province to another—at least in the eastern Provinces. In Nova Scotia, the Province is responsible for the river or stream but the Dominion has jurisdiction over the fish. The Province is responsible for public works and the Dominion for regulations. The Province charges a (nominal) license fee for salmon fishing, for example, yet the Dominion sponsors most of the research. The Province, in establishing a license fee had no explicit new program of resource improvement to offer to salmon anglers. It is possible that a different set of institutional arrangements would assist in the development of data essential to the development of more sophisticated supply and demand analysis and management than has been undertaken hitherto.

V. In summary, I have assumed that the economic valuation of a resource, such as the sport fishing resource for Atlantic salmon, can be treated in terms of a method that does not require an estimate of its capitalized value, although this is what could take place if we were to manage the resource as an enterprise or a series of enterprises and regarded the expenditures for their maintenance as investments. Taking into account all the relevant factors, including the time period and the discount factor, we would spend money on the maintenance or

expansion of the resource as the case may be so long as the discounted value of the prospective net proceeds did not fall below the capital outlays. This proceedure would involve, I should think, the supplying of the resource more within the framework of the pricing system than now occurs. There is a variety of ways in which the price system could be applied.

Furthermore, I have not mentioned quotas on the number of rod-days each fisherman may fish as a means of restricting demand. It may be worthwhile to consider matters such as these. I assume it is permissible to raise the question whether it is reasonable to permit a resource to be available without restriction as to the extent of utilization per fisherman under conditions where demand clearly presses on supply.

I have attempted to show that there are some conceptual matters which merit clarification. The good with which we are dealing needs clarification or definition. I have referred to it simply as sport fishing resources which comprise a number of complementary parts. There are wide real differences in the resource. Clearly, some resources will not merit development economically, others will be suitable for multi-purpose use, and others suitable primarily for sport fishing. If the economist is asked to provide answers to questions which have a bearing on policy, he must proceed on the basis of economic data. If the resource is to be provided or made available virtually on a free and open basis, the economist, with sufficient biological and engineering data at his disposal, will be able to suggest the least cost method of developing the resource, whether for single or multi-purpose use. But the economist would be assisted in his analysis if he knew more about the demand side. This would involve studies about the quantity of sport fishing resources demanded under various conditions and the relevant factors influencing demand.

While obviously enjoyment or satisfactions are a central part of demand theory, they cannot be dealt with directly owing to problems of measurement and of making interpersonal comparisons. This problem is a major one in welfare economics and leads to great practical difficulties in connection with concepts such as social costs and social benefits. It may be sufficient, therefore, as a first approximation not to become involved in unduly complicated and sophisticated analysis but to proceed perhaps on the basis of revealed preference theory of demand as related to expenditures,[1] and to compare the demand side of the equation with the economics of supply.

REFERENCES

1. BAUMOL, W. J. or SAMUELSON, P. A. — *Economic Theory and Operations Analysis.* (Englewood Cliffs, 1961). *Foundations of Economic Analysis.* (Cambridge, Mass., 1947).
2. MARSHALL, ALFRED. — *Principles of Economics,* 8th Edition. (London, 1961).
3. SEWELL, W. R. D. et al. — *Guide to Benefit-Cost Analysis.* (Ottawa, 1962).

SUMMARY OF DISCUSSION

Panel III: Research Requirements.

The substantial growth in both freshwater and salt water sport fishing in line with the general increase in demand for recreation facilities; the perennial conflict between sport fishing and commercial fishing and between sport fishing and other uses of the resources; and the increasing need for policy decisions by fishery resource managers and administrators were strongly emphasized as pointing to the need for research into all the aspects of sport fishing.

Dr. Walford described recent salt water game fish studies initiated in the United States which deal with life histories, distributions and environment. Considerable stress has been placed on the need for statistical data relating to the fish and the fishermen. The author indicated that before effective conservation measures can be developed research must provide information on fish habitat, artificial propagation, relocation of species and pollution.

Dr. Northcote indicated that many aspects of freshwater fisheries research in Canada have been neglected in recent years. He suggested in general that greater emphasis should be given studies of the environment, the fish and the fishermen. In particular he referred to deficiencies in data on river and stream habitat, impoundments, winter limnology and development of environmental control. It was pointed out that information on the juvenile stages of sport fish species is inadequate and for competitor species it is practically non-existent. The author also indicated that there is a definite need for additional research on the physiology of game fish species. The lack of information on population dynamics of freshwater fishes has made scientific management almost impossible.

On the research needs for the development of the economics of sport fishing, Dr. Morse pointed out that his approach was still in the realm of pure theory. His view of economics as a social science is as a way of thinking and his effort was to cast the problem in the traditional economic form of demand and supply which would yield an equilibrium level. Thus he was interested in identifying the "good", i.e., the fish and its habitat. The volume or quantity of these resources would represent the supply side while demand would be revealed in the activity of sport fishing not necessarily in the quantity of goods and services demanded by sport fishermen. Thus research should try to provide information on sport fishing resources (their quality and extent of competition for their use), characteristics of the fishermen and their response to changes in quality of the resource.

Panel members commenting on papers dealing with biological research requirements agreed in general with points dealt with by the authors. The need for the collection of statistical data was emphasized on several occasions. It was also noted that fundamental and applied research should be properly co-ordinated with careful planning preceding research projects.

In a reply to a question Dr. Walford indicated that his agency has been assisted with the collection of data by a number of amateur enthusiasts.

In the socio-economic field a special plea was made for research on the sport fisherman himself—who are the sport fishermen, what age groups do they fall in and what motivates them to sport fishing?

In summary seven areas for research were suggested:

(1) what makes people fish at various prices or costs,

(2) the quality of the resource,

(3) effects of changes of supply of sport fishing, quantitatively and qualitatively,

(4) effects of access to sport fishing resources. Do visitors increase with easier access, do they come more often and do they stay longer?

(5) what are the incomes of sport fishermen?

(6) what use is made of sport fishing catches?

(7) what is the nature of the incidence of multi-purpose uses of sport fishing resources.

In conclusion the participants extended encouragement to researchers who were reminded that policy makers were waiting in anticipation for research results.

IV—STATISTICAL NEEDS

(January 7, 1965, 9:00 a.m.—11:00 a.m.)

PANEL MEMBERS

Chairman

W. R. HOURSTON,
Director, Pacific Area,
Department of Fisheries of Canada,
Vancouver, B.C.

Author of Background Paper

A. L. W. TUOMI,*
Research Economist,
Department of Fisheries of Canada,
Vancouver, B.C.

Other Members

G. W. ANDREWS,
Assistant Director, Industry Division,
Dominion Bureau of Statistics,
Ottawa, Ont.

J. L. RAMESBOTTOM,
Travel Statistics Unit,
Dominion Bureau of Statistics,
Ottawa, Ont.

M. W. SMITH,
Biological Station,
Fisheries Research Board of Canada,
St. Andrews, N.B.

V. R. TAYLOR,
Chief, Fish Culture Development Branch (Nfld.),
Department of Fisheries of Canada,
St. John's, Nfld.

**Present address: Department of Fisheries of Canada, Ottawa, Ont.*

Panel IV, "Statistical Needs," Left to right, J. L. Ramesbottom, A. L. W. Tuomi, M. W. Smith, W. R. Hourston, V. R. Taylor, G. W. Andrews.

STATISTICAL NEEDS IN THE MARINE SPORT FISHERY FOR PACIFIC SALMON IN BRITISH COLUMBIA

by

A. L. W. Tuomi

Introduction

For many years the sport fishery occupied a quiet and comfortable niche as an almost incidental user of the marine fishery resource in British Columbia. This is no longer the case. Starting in the late 1940's sport fishing was caught in the metamorphosis that has taken place in the resources-straddling field of recreation; an activity which neither recognizes administrative boundaries nor respects time-honoured patterns of natural resource use.

The more obvious factors in the growth of recreation are well known: increasing population, unprecedented affluence, more leisure time, better transportation, and new and better materials and performance in recreational equipment and supplies. Not to be overlooked is the fact that recreation as associated with tourism is big business, and the incentives and opportunities in this "growth" industry have themselves become an important contributing factor pressing for continuing growth and expansion in recreational opportunity.

Crowding these is the newest facet of technological advance—computerized automation—which according to one expert will give "an acceleration on top of acceleration" that will, he predicts, bring a work displaced millennium within ten to twenty-five years.[1]

Forecasts such as this, and their relation to the emerging role of recreation, may seem fanciful and far removed, but there is nothing academic in the implications of the challenge that recreational demand is already posing, particularly where various factors and circumstances combine to bring pressure to bear on fishery resource use. A recent case was the Oregon initiative which would have banned all commercial fishing on the Oregon side of the Columbia River. If it had passed it would almost certainly have been followed by promotion for a similar move on the Washington State side.

This brings us to the main purpose of this paper. It is to explore the statistical information that is presently available on the marine sport fishery, and to look beyond this and discuss what information can and should be made available to bring the sport fishery into meaningful perspective, for both the present and the foreseeable future.

---

[1] Bellman, R., Rand Corp., as quoted by E. Haveman in "The Emptiness of Too Much Leisure" in LIFE, February 15, 1964, Page 74.

These matters will be discussed largely in the context of the marine sport fishery for Pacific salmon in British Columbia. This is due in part to familiarity with this fishery, but also because the tidal fishery resource in British Columbia has problems and conflicts that make it an ideal subject for this purpose.

Characteristics of the Tidal Sport Fishery in British Columbia

The tidal sport fishery in British Columbia is to all intents and purposes the salmon sport fishery. Other species of fish are available and are taken, but the two species of salmon—chinook and coho—are the status sport fish. Pink salmon are also being taken in increasing numbers during their cycle years but they are not held in the same high regard as a sport fish.

Administration of the fishery in British Columbia is divided, with the Province responsible for the freshwater fishery and the Department of Fisheries of Canada for the tidal fisheries. Due to both the characteristics of salmon and the nature of the waters the sport fishery is almost completely a boat fishery. As a result the catch per boat-day is the basic measure used in both field estimation and in all published reports.

Probably the most notable feature of the salmon fishery is the fact that it is essentially under full commercial exploitation along the entire coastline of the province. By contrast 95 per cent of the 1963 sport catch was taken close to the major population concentrations situated along the relatively short stretch of protected waters between Vancouver Island and the mainland, extending from Campbell River in the north to Sooke in the south. Here the sport fishery accounted for 24 per cent of the catch of chinook and coho taken in these waters in 1963 as compared with only the 6.3 per cent that sport fishermen caught of the combined province-wide commercial and sport catch of these two species for the year. (2) About three-quarters of the 1.7 million population of British Columbia is found in this southwest coastal region, thus it is in these waters that the sport fishery is recognized as a significant factor in the fishery, and it is here also that the conflicts arise between commodity use and recreational use of the resource. The conflict is primarily concerned with the two species of salmon—chinook and coho, which besides being highly regarded by sport fishermen for their fighting qualities, are also the premium salmon for the commercial fresh, frozen, and cured market. For instance, a red fleshed chinook at the bottom of the "tyee" weight range (30 pounds) would be worth approximately $21 dressed, on the Vancouver market. (3)

A license is not required to fish for sport in the tidal waters of British Columbia and traditionally restrictions on sport fishing have been kept to a minimum; with the main one being a relatively generous daily bag limit of eight

---

[2] Department of Fisheries of Canada, Pacific Area, "Statistics on Salmon Sport Fishing in the Tidal Waters of British Columbia, 1963", Vancouver, B.C., March, 1964.

[3] The landed market price for large red chinook on the Vancouver market during the week ending August 29, 1964, was 83 cents a pound. "British Columbia Fish Marketing Report", Department of Fisheries, Pacific Area, Vancouver, B.C., Sept. 2, 1964.

salmon, of which not more than four can weigh over three pounds. [4] Entry into the commercial fishery in British Columbia is also relatively easy as any Canadian citizen can obtain a commercial trolling license for one dollar; however, the commercial fishery is overexpanded, and the net fishery, particularly, is stringently regulated. One result of this easy entry is that a person can take advantage of both trolling commercially and fishing for sport, yet at the same time avoid responsibilities inherent in each. This practice, which is posing problems, is given encouragement by the high market value of salmon.

In the absence of a statutory requirement such as licensing of sport fishermen, and because catch figures are not a direct measure of effort, there is no simple way to gauge the actual increase in demand for sport fishing in B.C. tidal waters.

The various supporting enterprises, such as fishing resorts, marinas, boat rentals and charter boats, sporting goods supply outlets, etc. have increased in number and have become very much more important to regional economies as well as in relation to the competing commercial fisheries in the same areas. Here again, however, these enterprises are changing in character in keeping with the enlarging scope and nature of the recreational market they serve and as a result statistics on their stature, and trends of development, are in a no-man's-land of statistical responsibility.

Two examples perhaps will suffice to give some indication of the increasing opportunity for participation and the resultant increase in demand that can be expected to be brought to bear on the fishery resource.

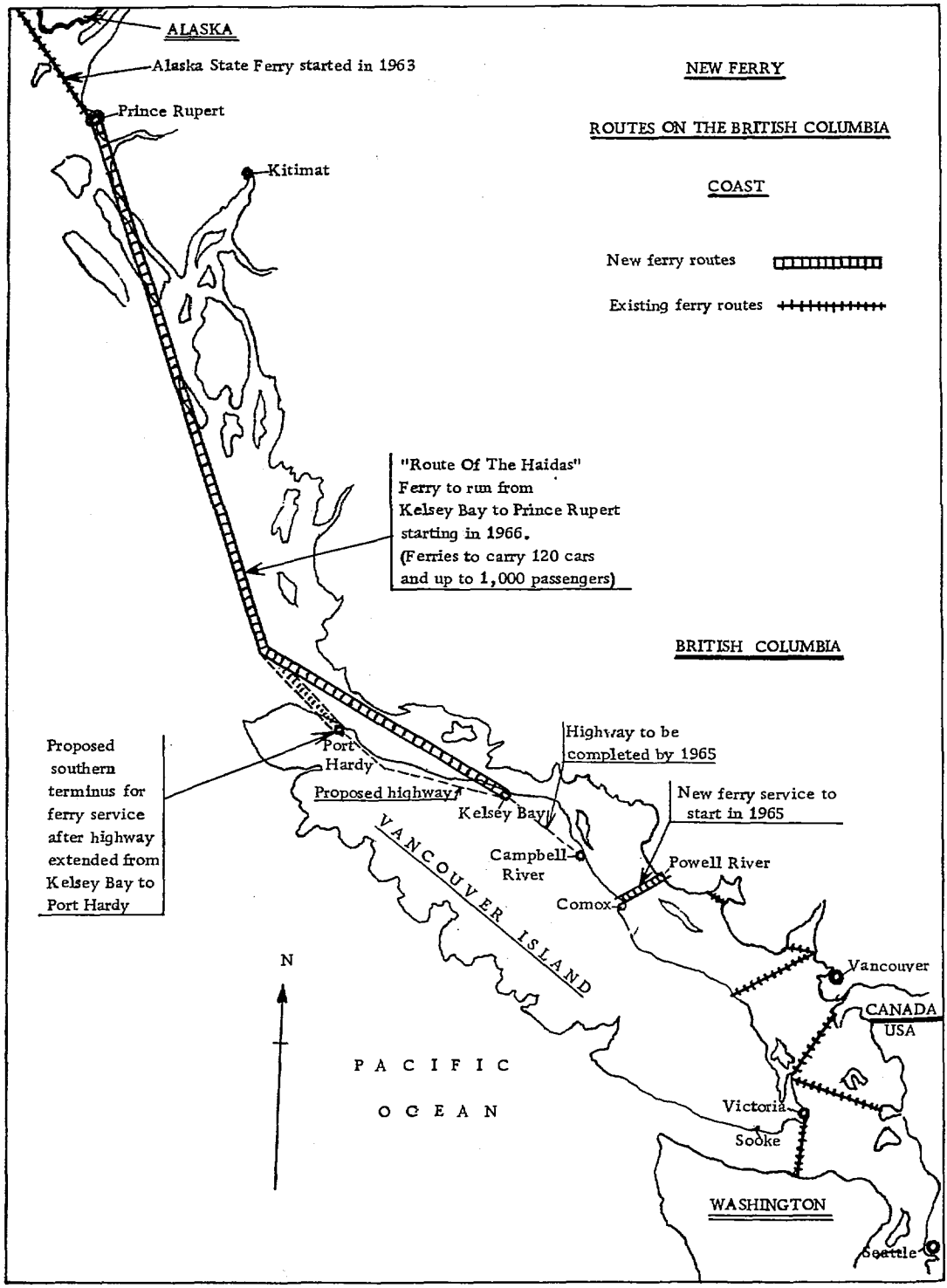
The first of these is the increased entry of U.S. pleasure craft, principally into the protected sport fishery waters of the Strait of Georgia. The total number of entries, through three of the more important southern entry points, has increased progressively from 3,098 in 1959 to 5,873 in 1963. [5] Not all boats are necessarily used for fishing, but 94 per cent have fishing tackle on board.[6]

The second example reflects the significance of access. At the present time relatively few sport fishermen go north of Campbell River. This will change shortly. A highway will be completed to Kelsey Bay in 1965, from where the first ferry service is scheduled to start in 1966 on the "Route of the Haidas" to complete the last major link in the highway-ferry service to Alaska. As soon as justified, the highway will be pushed still farther to Port Hardy at the northern end of Vancouver Island as shown on the map on page 118. When this phase is finally completed it will almost double the present extent of southern protected waters readily accessible and available to sport fishermen by both road and ferry. In addition, an accompanying influx of pleasure craft can also be expected to follow by water. Fishing resorts will probably also develop adjacent to ferry stops along the hitherto untouched and protected waters of the northern half of the British

[4] Small areas of water at the head of three inlets in British Columbia have special seasonal regulations to conserve runs of trophy size chinook. Sport fishermen are required to obtain a no-fee special salmon angling license.

[5] Compiled from information obtained from Collectors of Customs and Excise, Department of National Revenue.

[6] From an unpublished Departmental survey of U.S. pleasure craft registered for sport fishing in the tidal waters of British Columbia in 1961.


ALASKA
Alaska State Ferry started in 1963
Prince Rupert
Kitimat
NEW FERRY
ROUTES ON THE BRITISH COLUMBIA
COAST
New ferry routes
Existing ferry routes
"Route Of The Haidas"
Ferry to run from
Kelsey Bay to Prince Rupert
starting in 1966.
(Ferries to carry 120 cars
and up to 1,000 passengers)
BRITISH COLUMBIA
Proposed
southern
terminus for
ferry service
after highway
extended from
Kelsey Bay to
Port Hardy
Port
Hardy
Proposed highway
Kelsey Bay
Highway to be
completed by 1965
New ferry service to
start in 1965
Campbell
River
Powell River
Comox
VANCOUVER ISLAND
N
PACIFIC
OCEAN
Vancouver
CANADA
USA
Victoria
Sooke
WASHINGTON
Seattle

Columbia coast. At the present time one can only conjecture at the speed of the actual growth of sport fishery demand that this will bring, but it is easy to underestimate in this general field. A pertinent example can be drawn from the experience of forecasters on the Alaska State Ferry System which began operating from Prince Rupert to Juneau in 1963. This is indicated in the recent statement that "During the period June 30, 1963, through to July 1, 1964, 95,983 passengers and 19,510 vehicles have been carried on the ferry system, which exceeded the traffic estimated for the fourth year of operation."[7]

Statistical Objectives and Criteria

Sport fishery statistics inevitably reflect both the availability of information and the importance attached to prevailing requirements. Historically, licenses were undoubtedly introduced for varying reasons of control, regulation, and information on fishing related to conservation; but it is difficult at any time to disassociate licensing from its prime modern justification of producing revenue. Licensing generally produces revenue and at the same time provides a source of information. However, it should be noted that there has been remarkably little improvement in licensing for obtaining information as compared with the numerous major advances that have been made in the means of gathering biological data.

The need for information on fish, and on catches, developed early as a result of concern over stocks of fish and their continued availability. This was particularly the case where fish were exploited commercially, or where the circumstances were such that sport fishing appeared to have a depleting effect. The pursuit of all forms of biological information has made tremendous strides. But this information has been sought with relatively little attention to the people using the resource, except where user data was required for regulatory purposes, or for use in computing of catch. The protection of stocks was the all important need. This is not surprising as it fits into the general pattern of frontier development where people are few and resources plentiful, except that in the case of anadromous fish it was soon recognized that certain information was needed to protect and conserve stocks.

Statistical needs have changed but some of the patterns of statistical information still being compiled reflect concern and adherence to requirements appropriate to earlier and simpler needs. Expansion as well as updating is necessary in the face of new and more complex modern requirements. This applies both to statistics and the method of obtaining them.

The current statistical needs in the sport fishery can be discussed under three general headings: biological, administrative, and socio-economic. They are discussed in this order.

1. *Biological*

With the knowledge that the long term demand for fish for both food and sport is upward, and the increased awareness that all fishery resources are

[7] "1964 Transportation Committee Report to the Alaska—British Columbia—Yukon Conference", Whitehorse, Yukon, Canada. September 15, 1964. Page 2.

ultimately limited in supply—either in physical or economic terms, or both[8]—there is an ever-increasing need for what is generally called biological statistics. These can be classified as follows:-

First there is the need for continuing descriptive statistics that supply the current information which ultimately appears as the historical published record of what, when, where, how, and how many of the various species of fish were caught, and some data on the stocks fished and the numbers left for reproduction. Closely associated with this is the second need—particularly where stocks are amenable to management—for a rapid reporting of applied management statistics that serve as guide lines for direct use in the assessment and regulation of the fishery as it is occurring. This involves such information as time related catch figures on progressive stages of fish runs, the number of units of effort, measures of catch success, where fish are being taken, and by what gear. The size and weight of fish, stage of development, condition, etc., also enter into this, particularly as related to corresponding historical statistics. Frequently merging in with this, or emerging from both of these, is the third form of statistical information that is needed. This is the field of fundamental research where statistical information is often accumulated and needed by those directly involved, but where most of it is in a form and of a type which often limits its direct value to the specific research purpose.

2. *Administrative Statistics*

Administrators require a comprehensive over-all picture of what is involved in the sport fishery. This consists of administrative sport fishery population statistics—or in the absence of any other completely satisfactory designation—simply, administrative statistics. Historically when this general type of information has been sufficiently strongly needed it has been primarily obtained or derived from license records. The fact that licensing can also provide revenue which is frequently difficult to obtain otherwise has probably lent considerable support to the view that some means of licensing individuals is the only way to obtain this type of information. However, as discussed later, the needs for this type of information have increased beyond the capability of traditional license usage to satisfy.

Our precepts of government demand that administration must concern itself and think of society as a whole. In terms of administrative statistics this first of all requires adequate information and understanding of the needs and claims of all of the people who are involved in resource use. Directly in conjunction with this, there must be the comparable related information on the physical quantities and values arising out of this use of the resource so that all resource measures and values can be set forth and assessed in terms of their contribution to the maximization of benefits to society as a whole. Essentially, this requires two levels of information. The first is internal and covers the broad range of descriptive statistics and specific information that resource administrators must

[8] Crutchfield, J. A. "The Role of the Fisheries in the Canadian Economy", Resources for Tomorrow, Queen's Printer, Ottawa, 1961. Volume 2, Page 741.

have, either formally or informally, in order to be able to exercise effective management direction. Until recently this phase of information, for obvious and compelling reasons, has been primarily concerned with fish. However, as user demand increases in relation to stocks, management is inevitably forced into assessing the increasing number, nature and value of competing claims.

The second level of information required is more general and consists of broad industry statistics that will enable the status, production, labour force and other broad measures of the resource to be compared and examined in relation to other sectors of the economy. This can lead to the question of overlapping of administrative statistics and economic statistics, but essentially both are to a large measure the same as far as descriptive information is concerned. The point of distinction comes when interpretative analysis is given to administrative statistics and values are ascribed and imputed for this analysis.

Administrative statistics on the people using the sport fishery should include data on their number, their basis of eligibility to participate, where they come from, where, when, and with what they fish, as well as other related information that may be required for regulations or for other primarily descriptive detail on the participants. The data on their use of the resource should include specific information on the fish caught—number, species, weight, place, etc.—as well as related descriptive information on how fish are caught, with what effort, gear and equipment, etc., that will put the sport use of the resource into a measured perspective comparable to any other form of exploitation.

Administration also requires data on the ancillary industry that serves the sport fishery. This is useful and especially necessary for broader recreational or tourism appraisal. However, this information is no substitute for satisfactory data on the people participating.

3. *Socio-Economic Statistics*

This heading automatically includes all descriptive administrative statistics. Desirable as it might be it is hazardous to try to define the broad scope of the additional statistics and data required and usable in this category. There are no exclusive disciplinary domains. The biologist's task, for example, includes the accumulation of the wide range of fundamental knowledge and experience needed to assess, understand and manage fish and fishing. Likewise, economists must bring their equally specialized skills to bear on developing and analyzing the basic information that will bring the demand side of resource use into meaningful form. Due to such things as the absence of market pricing in sport fishing, this also involves working with and drawing on the work and findings of other social scientists.

In this light the administrative statistics on the people who participate is the starting point for socio-economic statistics. These must be supplemented with information in depth that can give answers to questions such as who are the people who fish, what use do they make of their catch, what do they spend in terms of time and money on fishing. Where there is competition between commercial and sport use answers must ultimately be sought on what motivates

people to fish, how do they benefit and how do the values of this compare with values arising from other forms of use. Extending the scope of this to the sport fish industry indicates the need for information on what is the present status and potential role of sport fishing in tourism and recreation. Answers are needed to such questions as whether the sport fishing is a desirable way to "sell" fish to the resident tourist or for "export" in the case of fishermen from other countries.

Considering the major differences and requirements in each category only a general statement can be made on common criteria for the three types of sport fish statistics.

The statistics must be as accurate as is justified by the various end uses. If the information is obtained directly from the public the means and methods used must be concerned with long-term public acceptability. Desirably this means that the public should be kept informed of the purpose and value of the information being obtained. Administrative feasibility is necessary. This suggests that it be kept as simple as possible, except that simplicity should not be gained at the sacrifice of a co-ordinated approach that will take care of all internal resource needs as well as the equally important need for conceptual compatability for integration into over-all recreational analysis.

One aspect of both administrative and economic statistics demands special attention. The sport fishery is in transition, but not only is it a matter of physical expansion, but also in the process values are changing. This reflects social and economic forces operating throughout our society which must be taken into account in long-term resource planning. This puts a dual burden on administrative and economic statistics. Not only is it necessary that they reveal the present status of both supply and demand in the sport fishery, but also the statistics should include measures that ensure continuity in revealing where and how change is occurring and the rate of change. Thus an initial need is for an inventorial assessment of the sport fishery, setting forth all the important physical measures and the estimated values involved. This can then serve as the bench mark from which changes and the rate of change can be measured. This also suggests the need for the development of a continuing system of gathering statistics that will not only take care of present requirements but also one that will be sufficiently flexible to grow and adapt to foreseeable future requirements.

Existing Statistics and their Adequacy

In assessing sport fishery statistics presently available in relation to the broad categories of information discussed, it is useful to look at the information according to source. Essentially sport fishery statistics are obtained from one or more of the following: through statutory resource requirements such as licensing; from sampling that includes everything from a complete census to various forms of field and questionnaire sampling; and thirdly from records maintained by others.

Tidal sport fishery statistics in British Columbia are almost entirely based on field sampling. They are almost completely biological in intent and application even though they do provide some general administrative information on the sport use made of the resource and its relationship to the commercial fishery. The information that is published annually is confined to the salmon catch by number, species breakdown, place and month. An estimate is included on boat days of effort, but no attempt is made in these publications to translate boat days into number of fishermen actually participating. Special studies and surveys are also made during which questionnaires are distributed and various estimates made of effort and catch, but there is no continuing basis for publishing any statistics that directly relate to total participation and its breakdown. In effect there are no administrative statistics on demand in terms of numbers of people. This seriously qualifies economic estimates and analysis that might be made on participation based on either crude estimates or on other sources of information. In short, the statistics available are almost entirely on the supply side, thus providing only the supply half of administrative statistics, and essentially leaving nothing of definitive substance for economic analysis that can go much beyond this.

In this regard it is necessary to remember the overwhelming importance and catching capabilities of the overexpanded commercial fishery as the primary factors to be considered in resource management in British Columbia. Because of this, and the added fact that the sport fishery is an inefficient fishery that essentially becomes significant on a regional basis only through numbers, it is not surprising that the sport fishery information has been developed on a supplementary basis in keeping with its hitherto relatively minor importance to resource mangement and use.

Because of the major economic importance of the commercial fishery for salmon, funds for biological purposes have been fairly readily available. Hence there has been little reason to look on the sport fishery, and the licensing of sport fishermen, as a source of revenue. Likewise the effect of the sport fishery on stocks has been small and until recently there has been little reason or need for any specific biological information on the sport fishery which could not be derived in one way or another from the commercial-fishery-based biological approach to the resource.

This situation has changed, however, manifesting itself in various regional requests by sport fishermen and the sport fish industry for a greater "share" of the catch together with various suggestions for restricting commercial fishing. This has led to the questioning of the adequacy of some of the present information. The nature of these problems points to the need for an adequate base of numeric information on demand that is not presently available.

Because of growing sport fishing interest a program of biological assessment of chinook and coho stocks in the major sport fishery waters of the Strait of Georgia was started in 1963. Not only does this represent the start of a major attempt to define stocks and their differential availability to sport and commercial gear, but it also requires a new level of catch and effort reporting to fit into and reveal the significance of biological data obtained. Although there may be reser-

vations regarding the value of specific management of the sport fishery, there is a clear need for a catch and effort reporting sufficiently sensitive to readily reflect management intervention and its significance where both commercial and sport fisheries operate.

This leads directly to the adequacy of existing catch statistics. When started in 1953 methods were used in estimating the catch that were common along the Pacific Coast. This consisted primarily of more or less continuing field sampling that was used in conjunction with a derived relationship between rental boats and privately owned boats to make over-all estimates of catch. This relationship between boats has changed and in many areas it has lost most of its value largely due to the rapidly increasing number of privately owned boats. Supplementary information has also been obtained from aerial counts of boats, and the extensive use of questionnaires as a checking device. Despite the general acknowledgement that these statistics have been adequate up to the present, there are strong reservations about their adequacy for the more accurate and more sophisticated needs now emerging.

The present figures have to be regarded as conservative estimates. In part this is because they are obtained in the field by personnel who enforce catch regulations and who are also confronted with various problems caused by the widespread nature of the sport fishery that make consistent estimating difficult for the limited man hours of time available for coverage. The major problem, however, involves adequate sampling for catch success, as well as for effort, for use in calculating over-all catch. Besides the lack of firm participation figures there is the knowledge that the sport fishing population is changing, is highly mobile, and varies considerably in terms of sport fishing catch capabilities. Recognition also has to be given and some allowance made for field difficulties in obtaining an adequate sample where perhaps a fifth of the fishermen catch over three-quarters of the fish. Surveys and questionnaires cast light on this but they are of limited use as a solution to the problem revealed.

Turning to the information available from records maintained by others, it is quickly apparent that there is a remarkable dearth of information on recreational boating in British Columbia when related to its magnitude and economic importance.

The Department of Transport has compulsory requirements which are primarily designed to provide an identification record, both on registered vessels as well as on small licensed vessels. Two separate unrelated systems are used. Because of this, as well as other complications, these records are of limited value in arriving at any types of estimate on the number of boats available for use in the sport fishery. Moreover, boats equipped with motors under 10 h.p. are exempt from these requirements. Customs records on entries of U.S. pleasure craft entering B.C. coastal waters have by contrast been very useful in showing the sharp increase in this traffic. No similar information, however, is available on the number of car top and trailer boats which come in large numbers from the United States and also from inland British Columbia and elsewhere in Canada.

Industry statistics, such as compiled by the Dominion Bureau of Statistics, give very little specific regional coverage and information related to the tidal sport fishery. Sales of fishing tackle and supplies can indicate broad trends, but these are primarily pertinent to the tackle industry. Figures on boat manufacturing and sales likewise can show trends, but to be meaningful in British Columbia they must be supplemented with information on the relative importance and trends on boats being built or assembled, both at home as well as on a semi-commercial hobby basis. Statistics available from manufacturers, retailers and other trade sources are of limited use, except on a very broad regional basis.

Before drawing conclusions it is interesting to note the experience of adjoining United States agencies which are also concerned with the salmon sport fishery.

In California they have had many years of experience with off-shore salt water licensing and have made extensive use of license records as a sampling basis for catch estimates, and to a limited extent for information on expenditures. A review of their experience with catch estimates based on year-end postal-card questionnaries, as compared with mandatory party boat records and field sampling, appears in the January, 1964, issue of "California Fish and Game Quarterly." In it Paul T. Jensen says, "It seems probable that both partyboat and skiff anglers exaggerate their success when responding to mailed questionnaires. To meet their primary purpose, postal-card estimates must at least reflect trends in landings. They do not do so in this fishery," and further, "...because of large and inconsistent differences between postal-card estimates and those based on partyboats plus sampling, salmon and steelhead will no longer be included in the statewide, postal-card angling survey."

Both a salt water license and a separate season limit salmon-steelhead punch card are required in Oregon. About 25 per cent of the punch cards are returned and are used in arriving at regional and total estimates of catch. This is supplemented by counts of boats participating, and stratified field sampling in certain locations. The need for sampling was commented on in 1963 in an address given by C.J. Campbell, Chief of the Fishery Division of the Oregon State Game Commission, when he said "Since some differences of recording can easily occur, the punch card data is more accurate and of more value as an estimate of the statewide catch than it is for specific areas."(9)

In Alaska, a single license is used for both salt and fresh water sport fishing. Licenses, and license records, are primarily used for enforcement (10) with sport catch data compiled regionally using a variety of field sampling procedures. (11)

The latest development in this field was started January 1, 1964, in the State of Washington with the introduction of a compulsory no-fee, no-limit, salmon punch card. These serially numbered cards are readily available from a large number of sport fishery outlets and are primarily designed to provide salmon

[9] Campbell, C. J., "Coastal Sport Salmon Fishery in Oregon", Fishery Division, Oregon State Game Commission, Portland, Oregon. Mimeo, May, 1963.

[10] Correspondance, State of Alaska, Department of Fish and Game, October, 1964.

[11] State of Alaska, Alaska Department of Fish and Game, 1962-1963 Dingell-Johnson Project Report, Sport Fish Division, Volume 4, Juneau, Alaska.

catch information both in the ocean and inland waters by region and date. Space is provided for showing a catch of 30 salmon on a card, and as it is completely divorced from catch regulations it is interesting to note that by mid-October one fisherman was on his way to completing his seventh card. [12] When a card is "punched out" as well as when another card is required for any other reason, similar un-numbered cards can be obtained with the stipulation that the number of the first card held by the applicant should be entered on all subsequent cards and stubs.

When cards are returned catch estimates will be calculated. This will be supplemented by field checking to provide the species breakdown. [13] Previously no form of license or punch card was required for ocean fishing and as 1964 is its first year of operation it may be some time before information may be forthcoming on the success of this approach.

This punch card appears to be primarily designed for more accurate biological statistics and should prove successful in this, but its value for administrative and economic statistics is less clear-cut. For one thing the lack of a fee removes the necessity for the tight accounting control required for a license, and in so doing can reduce the accuracy of participation figures. There are compensating factors involved in this, but the difficulty of maintaining control over punch card number continuity from first cards to subsequent cards would appear to add a further complication.

With the exception of British Columbia, all of the agencies noted have some direct statutory control over sport fishermen, and with the further exception of Alaska these records have all been used in one way or another in the estimating of catch. They are also the prime source of gross administrative figures on the numbers of fishermen participating in California, Oregon and Alaska and can be expected to provide a close estimate on this in Washington.

An examination of various license forms indicates that three basic types of information can be obtained and tabulated. The general information, primarily related to identification and enforcement, takes in such things as name, address, and the category of eligibility status according to age, residence status, etc. This also includes provisions related to period of licensing if less than a year. Direct resource breakdowns emerge from differing requirements by area or water fished, by species fished, and by form or manner of fishing. The third type of information is associated with resource use and hinges on the various combinations of fishing with hunting, trapping, etc.

Useful as all this information is, most of the license records do not provide descriptive administrative information and definitive break-downs that can be used directly for stratified catch sampling. This probably accounts for the development of punch cards which actually are a modified form of licence for obtaining better catch information. License totals do provide an over-all figure, and certain breakdowns of participation, but these gross totals can conceal profound changes occurring in sport fishing demand.

[12] "Fishing and Hunting News", Seattle, October 24, 1964.

[13] Department of Fisheries, State of Washington, "The Need for a New Salmon Sport Fishery Statistical System", Olympia, Washington, Mimeo, June 23, 1963.

Alternatives for Better Statistics

Essentially two courses are available for improving sport fishing statistics: improving existing systems or the introduction and development of new approaches.

In the case of the British Columbia tidal fishery there are many ways in which existing field sampling and estimation of effort for catch statistics can be improved. But even as admittedly necessary and valuable these may be, all advances along this line encounter diminishing returns. No real confidence in catch and effort projections can be developed pending the availability of some firm figure on over-all participation. This could be obtained in a number of ways. One consists of a census sampling survey carried out in all coastal areas, as well as inland, to establish a population figure on B.C. residents that fish in tidal waters. This would provide a wide range of very useful information, but the survey would be costly to carry out and in order to provide trend information and continuity it would be necessary to repeat it in whole or part on some fixed schedule. It would also have to be supplemented by fairly definite information on participation by non-residents and U.S. tourists, as well as by some means of cross checking this by field sampling. Besides the time lag in gathering information in this way, it is questionable whether sufficiently accurate regional breakdowns could be made of participation that would be directly useable for management requirements.

This leaves some form of statutory licensing or registration as the only serious alternative. The current experience with licensing of individuals, as well as more purposive license modifications, such as punch cards, have already been discussed. Further modifications of these approaches which directly relate to the individual are also possible and should continue to be explored. One new approach, at least in the sport fishery, is to obtain information through the vessel rather than the individual. This approach is outlined and discussed in a separate section.

Other jurisdictions can be expected to enlarge and improve their statistics, especially as related to the growing field of recreational use of ocean waters. However, useful as this information can be, it can only supplement, never replace, the specialized information required in the broad field of fisheries administration.

Some Conclusions from the Review of Existing Methods and Possible Alternatives

From the review of available experience it appears that no single method or system has yet been established as entirely satisfactory even for gathering catch statistics. In all cases there is a continuing need for on-site field sampling and checking to supplement catch estimates which, with the exception of B.C., are either derived from, or can be cross checked against some form of license record.

License records provide gross administrative information on participation that could conceivably be further developed by obtaining more information on license applications. However, the range in this would appear to be fairly short, both in relation to what the public is currently willing to comply with adequately, as well as by the real difficulties associated with devising license form questions that are significant in relation to the great deal of further information that is needed.

Despite the improvements that might be made in existing systems and sources of information there is nevertheless a clear-cut need for a direct, co-ordinated approach to supplying and providing depth on all phases of sport fishery statistics on a continuing basis.

In the absence of other proposals and substantially developed alternatives, this leaves only one approach—sport fishing vessel registration—that warrants serious consideration for this purpose in the marine sport fishery.

Sport Fishery Registration

Sport fishery registration is simply licensing, or registration, of all boats and vessels used for the tidal sport fishery. It would be mandatory for all vessels that are to be used in the tidal sport fishery, regardless of any other recreational or commercial use.

The principle involved is simple, based as it is on numerous commercial fishery precedents; however, some elaboration on this is needed. [14]

People, fish, and boats are the prime ingredients in the tidal sport fishery, but whereas fish—particularly salmon—can vary widely in number and availability, and people participate on a variable basis, subject both to the availability of fish as well as for numerous other considerations, boats fluctuate the least and are thus the easiest of the three to count. In this, not only are the numbers and purpose of boats on the water easier to account for, but also the relationships between people to boats, and between boats and the catch per boat, easy to use and already accepted in practice.

There are parallels in other resource applications, such as reporting on attendance in parks. The information may be given in numbers of persons but this is actually derived from vehicle counts which can, through relatively simple estimation, be easily translated into numbers of people. [15]

The catch per man is the obvious measure for catch success in land based fishing, but the catch per boat is a better one in a boat fishery where the boat as the basic unit of effort lends itself to easy use in catch checking and effort estimating. There is a parallel here too in highways. Road use is not computed in relation to the numbers of people with drivers' licenses, but rather through the stratified information available from vehicle registration records which contain breakdowns on the number of cars, motorcycles, trucks, buses, etc., which through analysis in conjunction with other data on the nature and characteristics of this traffic, actually provides the real basis for determining road use. In this respect it is appropriate to point out that there is a very wide range in pleasure craft in size, mobility, and capability for use under varying water conditions. This also relates to fishing success when handled by those with enough time to fish, and enough know-how to enable them to catch more than a proportionate share of the total catch.

[14] In addition to an individual fisherman license, a commercial fishing vessel license is required in the States of California, Washington and Alaska. The International Pacific Halibut Commission, established by Treaty between Canada and the United States, also requires a vessel license.

[15] This is described on page 124 of ORRRC Study Report 24 "Economic Studies of Outdoor Recreation", Superintendent of Documents, Washington, D.C., 1962.

Registration procedure would be largely similar to vehicle registration. The owners, or authorized agents, of all vessels would be required to fill out vessel registration application forms which would be freely available at sport fishing outlets. These would be mailed in to a central office, or brought into a limited number of regional offices, for forwarding to the central office. On receipt of a properly completed application a registration number would be assigned and a vessel license plate and wallet size certificate would be sent to the licensee. The plate would be required to be mounted on the vessel in a standard manner that would make enforcement and vessel identification a matter of visual checking. The vessel license number would be permanently assigned to that vessel, despite changes in ownership, etc., and would have to be displayed as long as the vessel is maintained in good standing as determined by validation on a set schedule. Validation could be bi-annually or as otherwise desired. Application forms could also be designed to serve as validation forms as well as for initial registration, advice of loss, change of ownership, etc. Provisions could also be made for temporary plates or decals to facilitate and speed registration for tourists.

Registration of this type would automatically yield a great deal in the way of administrative information and statistics directly from the registration sheets. The key here is that a boat is a material object and in keeping with automobile licensing and other similar requirements, questions can be asked and information will be given that would be difficult to obtain on a consistent basis in any other way. As shown on page 130, the application form would provide information on the owner, and a key descriptive breakdown on the vessel—its size, power, age, value and how and where it is kept, and the identification numbers and name it displays. From these, cross-indexed punch card records could be set up so that information could be readily obtained according to fishing registration number, or by any other identification basis desired.

The use of registration for obtaining biological, administrative and economic sport fishing statistics can be illustrated in turn.

1. *Biological*

Registration provides a flexible basis for providing better catch statistics in stages that can be directly related to the indicated level of need.

In its simplest form registration breakdowns would give the number and composition of all vessels that can engage in the sport fishery in each area. This would for the first time give the personnel in the field firm figures on the number of pleasure craft, both resident and foreign, that actually are available and used in the sport fishery by area. It would also do the same for other vessels that are not presently regarded as sport fishing vessels. Sight sampling in the field by registration number would also reveal the extent that boats from other areas would have to be taken into account in regional catch and effort estimates.

The next stage could involve mail sampling based on registration files. For annual statistics on effort and catch this would permit mailing questionnaires out to coincide with the close of the sport fishing season, thus reducing the adverse effect of time lapse usually associated with year-end questionnaires. In

DRAFT

APPLICATION FOR TIDAL SPORT FISHERY VESSEL REGISTRATION

Name of Vessel _____ _____ Home Port

Official Registry Number _____

or

Boat Licence Number _____

Address where Registered or Licenced _____

Sport Fishery Registration No.
Has vessel been registered for sport fishing before? Yes ☐ No ☐ If yes give number in box above.

Describe vessel: Length in feet _____ Powered by Inboard ☐ Outboard ☐

Inboard-Outboard ☐ Sail ☐ Other (specify) _____

Size of motor(s) in h.p. _____ _____ _____ Has it built in overnight accommodation Yes ☐ No ☐

Please estimate current market value of vessel & motor(s) _____

Please indicate the year the vessel was built. Estimate if necessary. 1965 ☐, 1964 ☐, 1963 ☐, 1962 ☐,

1961 ☐, 1956-1960 ☐, 1951-1955 ☐, 1941-1950 ☐, Prior to 1941 ☐.

Was it acquired new ☐, used ☐, or was it built by the present owner ☐

Is vessel moored year round ☐, or is it kept moored only during summer ☐, or is it transported as required by trailer ☐, or by car-top ☐.

Where is vessel kept in the summer _____ Where is vessel kept in the winter _____

Is the vessel used for commercial fishing? Yes ☐ No ☐

If yes, give commercial fishing licence number _____

Is it used for other commercial purposes?
If yes, please specify _____

Print full name of owner _____ _____
Family Name Given names

Permanent Address _____

Print full name of authorized applicant _____ _____
Family name Given names

Permanent Address _____

Date:	Signature:

Note: Sport fishing rental or charter boats are not to be registered on this form.

fact, specific questionnaires could be mailed out at any time to obtain information on such things as catch success on specific runs, effort in certain areas, fishing success from various classes of vessel or any combination of similar type of requirements. Notable in this would be the fact that information would soon accumulate that could be used to establish the basis for stratified sampling of vessels according to their importance to total catch. Field sampling and checking could then follow this up, thus contributing further to the build-up of this knowledge. Asking for the registration number on tag return envelopes enclosing tags taken from fish tagged for biological purposes would add another dimension to this information.

If even more specific catch information becomes necessary, then a boat log, or boat punch card, could be made mandatory. The only difference between this and an individual punch card is that it would be the owner who would be responsible for catch reporting for anyone catching fish from his boat. This could even be made a condition of registration. This essentially corresponds to the responsibility that the boat owner must automatically assume in many other respects. Boat punch cards could provide both over-all annual catch data as well as a fairly simple means of checking on catch during the season by abstracting or duplicating punch card data in the field.

2. *Administrative*

The bulk of administrative statistics would emerge directly from tabulation of registration applications, validations, transfers and dropouts. Not only would there be complete information on boats by type, size, and home port, but from this the trends that can influence participation in terms of boats should show well in advance of actual incidence. The question of the number of people participating could be estimated fairly easily from stratified knowledge of boat types supplemented by such other field and boat owner sampling as the end use may require. [16]

3. *Socio-Economic.*

Registration files would provide a revealing breakdown of the economic structure and regional distribution of the tidal sport fishery as represented in boat numbers and values. Relating the range in boat size and values to boat catch success could be used to determine the variations in the costs and characteristics of sport fishing on regional basis. More specific sampling could be directed to checking on the extent of travel for sport fishing for all classes of boats. This could lead, for example, to the application of the Hotelling approach to water travel by class of boats or by specific groups such as trailer transported boats. [17]

[16] Questionnaires from annual one day general surveys carried out in 1960, 1961 and 1962 showed that the over-all average for all classes of boats remained unchanged at 2.4 persons per boat. In 1964 the over-all average was 2.5 persons per boat. Department of Fisheries of Canada, Pacific Area. "Statistics On Salmon Sport Fishing In The Tidal Waters of British Columbia." Annual Reports for 1960-1963.

[17] Professor Harold Hotelling of the University of North Carolina proposed an approach to recreational benefit evaluation based on distance of travel. It initially appeared in the ("Prewitt Report") "An Economic Study of the Monetary Evaluation of Recreation in the National Parks," U.S. Department of the Interior, National Parks Service and Recreational Planning Division, 1949—as quoted in ORRRC Study Report 24. op. cit.

Generally speaking, sport fishery registration would provide a stratified reference frame, or base, from which to develop and explore various approaches to evaluation. The mere fact of registration—as fairly readily field checked to the number and characteristics of vessels not registered—could be interpreted to yield useable demand information. If a fee is tied into registration it would be fairly easy to look to some differential basis for a fee structure, including exploring the possibilities of charging a zone, or time based boat license fee. Both of these could, for instance, be investigated for use in an existing special salmon angling license area on a basis that bears some relationship to the trophy quality of fish available; or in some other inlet according to the costs of maintaining or developing a run.

It has already been noted that the boat—the catch enabling link—is the least variable as well as the easiest parameter to pin down in the marine sport fishery. However, the question can be raised as to why the fishery resource should bear the onus of setting up a vessel licensing system for sport fishing when nearly all marine recreational activities are boat based, with some, like cruising and water skiing, showing very rapid gains. Furthermore, most vessels already have identification numbers. The most obvious answer to this is that fishing is still rated as the single most important use made of boats, and of all the major uses, fishing is the only one that depends on the exploitation of a limited natural resource. No other major renewable natural resource is really affected in the same way by the growth of recreational boating. Likewise, there is little incentive for existing vessel marking systems to be drastically reshaped to meet a specific resource need when with relatively minor adjustments these systems can continue to perform their prime purpose. There is also the point that even if registration does clearly separate vessels that are used for fishing from those that do not, the vessels registered for sport fishing would inevitably still be used for many purposes and that this would raise complicated questions as to allocation. This would undoubtedly be the case; however, the problem of allocation of vessel use does not appear to be any more difficult to deal with than similar questions related to the breakdown of benefits an individual or a family derive from any recreational outing. In fact, stratification from vessel registration data should make allocations of boat use easier to identify.

Besides the advantages already dealt with, sport fishery registration would have a number of additional advantages:

1. Vessel registration is a case of working from the simple to the complex as it would only affect about a third of the number of people as compared with either an individual license or punch card. Likewise, registration is a logical first step that is compatible with, and can be supplemented by individual licensing if the need should develop.

2. Enforcement of registration is simple compared with an individual license, being primarily a visual operation that can be carried out either on the water or on the docks.

3. No license system is immune from resistance; however, registration is not weighed down with long standing resistance to a marine license nor with skepticism that has been often associated with punch cards.
4. Registration as compared with an individual license will create far less hindrance to tourism. For instance, the need to buy an individual license for a single fishing trip will not crop up to deter the casual trade of boat rentals and fishing resorts.
5. Registration has been mentioned in public statements to sportsmen's groups on a number of occasions, and comments invited, but no adverse reaction has been received. In addition, the general attitude of boat owners to keeping a boat log or record of fish caught was asked for in conjunction with a survey carried out in August, 1963. Out of 431 boat owners, 76 per cent replied that they would keep a record if a boat log or record was provided.
6. Statistical information available from registration would be useful to the many government agencies, both federal and provincial, that are concerned with recreation, tourism and regional development. The Navy, and Search and Rescue would find detailed rapid access files of great value, while the Department of Public Works, harbour boards and other similar bodies could use regional registration data in assessing and planning harbour and moorage facilities. In this regard a statistical breakdown of the lucrative high investment marine recreational boat market would be of considerable value to many sections of the business community.

Registration does have disadvantages and shortcomings. It would not, for instance, provide a basis for information on shoreline and pier fishing. It would also involve the setting up of an administrative unit to keep it operating and in a limited sense this might be considered a disadvantage. However, there are costs involved in any approach—as well as in delay. Compared with alternatives, the wide range of administrative flexibility in registration gives it the edge in costs over other comparable approaches to better information. This margin of advantage increases substantially when over-all benefits are related to costs.

Costs can be recovered and commercial fishery and motor vehicle practices suggest the wide range of possibilities in differential sport fishery registration fees to cover administrative costs as well as to produce revenue.

The charging of a registration fee is desirable for a number of reasons, including the fact that it would be one direct measure of what sport fishermen are willing to pay for sport fishing. The whole question of using registration fees as a source of revenue involves numerous considerations which go beyond the scope of this paper, but it is worth noting that there is adequate precedent in the commercial fishery for charging for both a vessel license and an individual license.

Conclusions

Looking at the statistics presently available in relation to the rapidly expanding need for information it is readily apparent that neither the existing

statistics nor the methods by which they are gathered are adequate to the challenge now emerging in the recreational fishery.

Biologically orientated catch statistics have been generally adequate to date, but recent events have changed this. Major programs of biological study have already been undertaken on sport fishing and these need to be matched with at least a comparable level of catch and effort information—not only to be available for use in increasingly sophisticated biological investigation, but as well to provide a flow of information for fishery management that is both meaningful as well as responsive to management intervention.

The situation regarding administrative statistics leaves a great deal to be desired, with most of it directly related to the lack of any specific or consistent information on what is actually occurring in sport fishery demand. This not only hampers understanding of the consumer attitudes prevailing in recreational participation, but it also dulls the opportunities for dealing with fishery problems through exercise of demand management.

The inadequacy, or outright lack, of sport fishing information is most evident in the field of economic statistics, and it is here that some of the problems are most pressing. One of these relates to the shift that is taking place between commercial and sport fishing on a regional basis. Considering the very many long-term implications of this shift, it surely warrants adequate economic delineation. Another area of interest relates to the role that sport fishing plays, and will play, in the over-all field of recreation. Most of the information on the changes that are occurring in income levels, hours of work, and the alternatives in recreational spending are reasonably available from other sources. However, to try to relate these to the sport fishery, particularly where there is no firm continuing information on participation, raises numerous difficulties that do little to lend credence to even the best of theoretical approaches to dealing with the significance of the sport fishery.

Working from the assumption that knowledge develops from knowledge there is a clear-cut need to develop a basic framework of statistical information that will bring the sport fishery into focus. In this it is difficult to avoid the conclusion that this has to be done directly and specifically by the resource agency.

The traditional approach to administrative information has been individual licensing, but there is serious doubt whether licensing can provide the depth of knowledge now needed. Looking at the experience in both the commercial fishery as well as in other fields, the logical first step in bringing marine sport fishery statistics into order is to concentrate on the vessel, and make use of the broad range of information that can be developed from this approach. Then, if necessary, individual licensing can follow.

Sport fishing registration is no cure-all, but it is the only system or means presently available for consideration that can provide a co-ordinated approach to the wide range of statistical information needed in the marine fishery. Besides its obvious flexibility for gathering catch information and its administrative value in providing a statistical picture of the sport fishery, it would also provide

the essential reference frame from which specific measures can be obtained for various theoretical approaches to evaluation. In this it may also reveal information that could give stimulus to the development of new procedures for evaluation.

Addendum

This paper on statistical needs was written in the context of the marine sport fishery for salmon in British Columbia. Thus, the description of the range of statistical information, and the discussion of the problems and principles involved in securing the information are to a lesser or greater degree relevant to any sport fishery. However, the problems outlined and the specific recommendations relating to the salmon sport fishery are not—and are not intended to be—directly applicable or transferable to the needs that can prevail in differing fisheries operating under differing circumstances.

BIBLIOGRAPHY

BENSON, D. A., *Fishing and Hunting in Canada—1961* Canadian Wildlife Service, National Parks Branch. Department of Northern Affairs and National Resources. Queen's Printer, Ottawa, 1963.

BROWN, WILLIAM. G., AJMER SINGH and EMERY N. CASTLE. *An Economic Evaluation of the Oregon Salmon and Steel-head Sport Fishery,* Agricultural Experiment Station, Oregon State University, Corvallis, Oregon, Sept., 1964.

CALIFORNIA. CALIFORNIA DEPARTMENT OF FISH AND GAME. *California Fish and Game.* Sacramento, Quarterly.

CRUTCHFIELD, PONTECORVO, ET AL. *Report to the Bureau of Commercial Fisheries on the Branch of Economics,* United States Department of the Interior, Fish and Wildlife Service, Bureau of Commercial Fisheries, Washington, D.C. April, 1963.

MICHIGAN. UNIVERSITY OF MICHIGAN. SCHOOL OF NATURAL RESOURCES. BUREAU OF OUTDOOR RECREATION, U.S. DEPARTMENT OF THE INTERIOR. *Proceedings of the National Conference on Outdoor Recreation Research.* Ann Arbor, Michigan, May, 1963.

OUTDOOR RECREATION RESOURCES REVIEW COMMISSION. ORRRC STUDY REPORT 7. *Sport Fishing —Today and Tomorrow.* Superintendent of Documents, Washington, D.C., 1962

SINCLAIR, SOL. *License Limitation—British Columbia: A Method of Economic Fisheries Management,* Department of Fisheries of Canada. Ottawa, 1960.

SUMMARY OF DISCUSSION

Panel IV: Statistical Needs.

The Chairman in introducing the topic indicated that although it is increasingly obvious that statistical information on the sport fishery is necessary, the obtaining of accurate statistics is difficult.

In the discussion that followed the presentation of the paper the method of recording participation in sport fishing was criticized for its limited application. Boat registration would not yield adequate results where non-boat fishermen are preponderant. The value of licensing all sport fishermen was suggested as one method for arriving at the universe and yielding a sound base for sampling. Comment was made on the evidence of some degree of resistance to licensing by sport fishermen.

The need was emphasized for conceptual planning among the various users of fisheries statistics to ensure the maximum value of the statistics. The needs of the fisheries biologist are for statistics of the fish and fisheries but not on the fishing itself. Statistics descriptive of the fish are generally available but there is still a need for historical series for their predictive value. A caution was expressed against disproportionate attention to the collection of statistics on sport fisheries of a high prestige value.

In establishing a collection system for statistics on a national basis problems are always present but these are greater when the industry consists of small and geographically dispersed units with generally inaccurate records.

Some of the inherent difficulties in establishing a procedure for collecting national statistics on sport fishing were listed as (a) a conceptual approach common to all sport fisheries, (b) the necessity of avoiding duplication of effort, (c) the exact definition of the statistics desired. However, the contributions of sport fishing to the economy are measured (but not separately) by the Dominion Bureau of Statistics. Because sport fishing is considered as an activity and not an industry, its contributions are included in the accounts of various industries.

SUMMARY OF SYMPOSIUM

(January 7, 1965, 11:00 a.m.—11:45 a.m.)

Chairman

A. W. H. NEEDLER,
Deputy Minister,
Department of Fisheries of Canada,
Ottawa, Ont.

Speaker

P. A. LARKIN,
Director, Biological Station,
Fisheries Research Board of Canada,
Nanaimo, B.C.

P. A. Larkin (left) and A. W. H. Needler discuss summary delivered by Dr. Larkin at conclusion of Symposium.

A.W.H. Needler:

Gentlemen, we have come to the last item of the program, which is the summary. It was intended that an economist would undertake the summation because this has been primarily an economists' symposium. As it has turned out, we have had to enlist an amateur economist, Dr. Larkin. I am sure though, knowing Dr. Larkin's ability, that it will not lack anything for this reason. I now call on Dr. Larkin to summarize this Symposium.

P. A. Larkin

I must confess that in undertaking this assignment in place of Bill MacKenzie, I feel very much like the proverbial "boy sent to do a man's job". In many respects this has been an economists' symposium, as indeed it should have been, and it would have been most appropriate for an economist to have summarized. But it has turned out otherwise, and if my comments should fall short of being an adequate summary, I trust you will be understanding, and consider it another of the improvisations that circumstances have forced on the symposium.

I've been assisted in preparing my comments by Mr. Harold Frick and Mr. R.A. Spargo of the Economics Service of the Department of Fisheries and should like to acknowledge their help. Not only have they given me a good short course of instruction but they also did translations from economics into English. I might say that this was interesting, economics reminding me of Japanese.

Because you will receive, by the end of the conference, a set of rapporteurs' summaries, it seemed inappropriate for me to duplicate their efforts by providing a chronological record of what went on here. Rather it seems better to make a summary comment which, one might hope, would put the conference in some sort of perspective.

First, it has been evident from the beginning that the conference was needed. Dr. Needler indicated in his opening remarks that the growing sport fishery in Canada promises to create situations, and perhaps has already done so, which will require the attention of fishery biologists and economists if we are to be confident of handling a potential resource skilfully. In some instances sport fishing must be managed in conjunction with commercial fishing. In other instances sport fishing is to be reconciled with resource uses other than fishing. And in still other instances, both sport and commercial fishing are to be managed in an environment in part devoted to other resource uses. These situations are becoming increasingly more common, and we dispensed with any lengthy recitation of the types of problems with which we are faced.

This failure to mention specific instances was perhaps a weakness in the conference. Our American colleagues could cite many instances of resource-use planning in which economic evaluation had played a part. Although there have been some similar appraisals in Canada, rather few were examined in any degree of detail. In consequence, I feel we are going home with insufficient case histories in mind—case histories which might have served to remind us of some of the broad principles we were discussing. Perhaps at the next such conference, and there will surely be one, we should plan to marshal more data to throw into a discussion.

Perhaps, for this is a first conference, it was preferable to deal more in general terms. It must be abundantly evident to our American visitors that we are only beginning to sniff around at a problem for which they can provide us with valuable experience—in the form perhaps of both good and bad example. (Although in many respects our situations are not parallel, their experience is valuable and we should take advantage of their generosity as long as they are willing to help us out.) But to return to the question of a conference of generalities, what were some of the general themes of the discussion and what conclusions could we draw?

Well, first, although it took us a long time to say it, we seem fully agreed that *economic analysis has an important part to play in our evaluation of sport fishing*. Thus, the fishery biologists have become convinced of the need for economists and the economists have been persuaded to venture into sport fishing evaluations. It could scarcely have been otherwise considering the circumstances, but it is worth recording nevertheless as a reminder to get on with a job to which to

date we have largely given only lip service. Our corps of economists is excellent but small, our problems are many, large and complex.

It seemed also to be agreed that the chore of *economic appraisal of sport fishing brings economists onto somewhat thinner ice* than the analysis of boot and shoe sales. A variety of intangibles are involved which involve human nature. In many instances there is no market in the classic sense. There are many avenues for alternate investment. If the evaluation of sport fishing is to be made by indirect means, a school or more of red herrings may be resurrected to confuse the issue. If reliance is placed on questions asked of honest anglers, there appear to be abundant opportunities for errors of interpretation. The application of a direct toll was suggested as a means of eliciting a response which would show something of the nature of the demand curve. But even such a direct approach seemed potentially fraught with complications. For instance, socially undesirable forms of discrimination might occur. Costs of administration might be high. Perhaps the toll, being small in relation to other costs, would fail to reflect demand. Obviously we shall need much more experimental management and analysis of case histories, such as the important and pioneer work of Mr. Spargo, before we shall gain confidence in our understanding of economic forces that operate in sport fisheries.

Rather surprisingly, I thought, *we did not spend much time in gazing into the future*, and seemed content with the superficial statements that sport fishing will increase. There are several facets to this question which might have been explored. For instance, at least some of the demand for sport fishing is generated by propaganda from resorts and tackle manufacturers. There is also tourist promotion literature from governments. Fisheries biologists have even been known to promote sport fishing. To what extent has this literature influenced our taste for sport fishing? To what extent could the demand be modified by other kinds of propaganda? For example, can we persuade the angler that many trash species are good sport? Is angling perhaps essentially a promoted industry? These would have been interesting questions to pursue for it would seem certain that the future will prove different from what we presently envisage. Certainly much of our sport fishery is influenced not only by American anglers, but also by the effect of these anglers and a barrage of American literature which influences demand in both countries. Our view of the future of sport fishing—our forecast of demand, could well be a subject for future discussion.

The questions of technique of evaluation and the prediction of patterns of future use were also shown to be vital ingredients in *assessments of the value of sport fishing in relation to other resource uses.* Some of us at the conference, and I include myself, have viewed with alarm almost any encroachment on sport fishing resources and have disparaged any evaluation short of infinity. But the more balanced view of the economist is undoubtedly a better guide to administrative decision, which it has been pointed out must clearly distinguish between the real economic values and the emotionally-based social values. It should be explained to anglers that an economic evaluation is one way of assessing his hobby, and

his arguments about a way of life, which included sport fishing, fall perhaps in a different sphere, perhaps in economics and perhaps outside, but in any event confusing the issues. It was argued that whatever method of evaluation was chosen it would be desirable that it be kept simple. (I understand this was so that engineers could understand it and the economists' rebuttal was that anyone who could read a sports page could understand economics.)

It was not until the second afternoon of the conference that the air began to clear from the smog of colliding prejudice and jargon and the issues were becoming clarified. The session on research requirements seemed to move in a more productive atmosphere.

Perhaps it is inevitable that a gathering of this kind should have enthusiasms for more research. Knowledge creates the appetite it feeds, and we have evidently enough background in economics and fisheries biology to have developed a hunger for much more information of joint value to both disciplines. The research requirements panel pointed specifically to many needs. Of more significance to this summary perhaps were their general comments. For example, it is important to create and preserve a proper atmosphere for research in agencies responsible for management of sport fisheries. Another example—it is important to think in term of maximum recreational yield rather than maximum sustainable yield. And third, attention must be given to study of the habits of fishermen, the contrary consumers of the commodity in question. Several speakers reminded us that our interest should be in the people, not the resource. It was stressed that there was need for "conceptualizing" the problem, and in several of the papers there were stimulating stabs in just this direction—organizing an economic approach.

This was all good stuff and should contribute substantially in promotion of research.

It seems clear that before too many years we should see the proliferation of a great many kinds of approach for a great many kinds of problems, and that from this there may emerge, in the words of one speaker, "The appropriate approaches for particular projects". Whatever the approach, it seems likely to be centred around economic appraisal and a constructive resource-use philosophy.

The discussion of statistical requirements both reflected and re-emphasized the nature of the problem of evaluating sport fishing. The difficulties of conceptualization imply the confusion as to what to collect as statistics, the public participation in recreation implies stratified sampling, the fragmentation of the resource implies the difficulty of representative sampling. The different kinds of sport fisheries may require different kinds of statistics. Joint planning of statistical programs by biologists and economists is the obvious requirement if statistics are to better serve the needs of evaluation. Finally, it was again emphasized that the idiosyncrasies of anglers, including their gross ineptitudes at catching fish, and their tendency to enjoy themselves with all sorts of outdoor recreations, instead of tending to the business at hand, are all a source of confusion to statisticians. There is obviously no substitute for a "grass roots" acquaintance with their angling habits.

The obvious conclusion to a conference of this kind is that it has been useful to have knocked heads together, and that we should plan to do it again soon. Meanwhile, having recognized a need for economic evaluation of sport fishing, we should get on with the job, tackling the research necessary if sport fishing is to be properly placed in the scheme of things at the local, provincial and national levels. I'm sure you will join me in thanking our hosts for arranging what has proved to be a productive and enjoyable conference.

A.W.H. Needler:

Thank you, Dr. Larkin. In gatherings of this kind there are two people who obviously have unfair advantages over everyone else. One of them is the person who presents a summary, as Dr. Larkin did, and the other one is the Chairman who has the last word.

In listening to Dr. Larkin's remarks, I realized that there were several provocative statements in it which I would like to argue with and doubtless many here might feel the same. These provocative statements are made at a stage when nobody has a chance to do that. However, perhaps this is the right note on which to end the Symposium, because a symposium of this sort is not a symposium to end all symposia. It is meant to stimulate us to have more and better work in this field.

One of my predecessors, whom many of you knew, and whom I have always regarded as the most brilliant man with whom I have worked, the late Mr. Stewart Bates, once said to me that fisheries biologists and economists had one thing in common: they were the only people claiming to be scientists who have the temerity to draw conclusions from complicated equations when they only have figures to put into one or two of the terms. I think that there are some parts of biology that might be considered an exact science, and that there are some aspects of economics that might be a little bit exact; but I think that this remark by Mr. Bates nevertheless has a lot of truth to it.

The biologist concerned with fish populations is often trying to formulate the correct regulations on very inadequate data: the fish can't be seen; they usually can't be counted; and such fundamental matters as the natural factors which control the varying productivity, survival, and so forth, are not at all well understood. As for the economist: I heard one of the economists here say that he would not attempt to analyse the desires of the anglers, and yet, surely all the values that he deals with are based on desire. The price of sugar or any other commodity depends upon this, and so the economist is in the same fundamental difficulty: he lacks a good bit of the fundamental basis for analyzing a problem of this kind. So it might look a little bit like "the blind leading the blind".

Yet I don't want to give this impression—I don't want to disparage the efforts of either. I hope the economists are making a firmer and more reliable prediction when they say that this year will be a prosperous one, than some biologists have made in predicting salmon runs. Nevertheless, it is perfectly clear that we are better off with what we have from the economist and the biologist, than with nothing.

But it is also clear that there is room for a great deal of improvement, on the part of both, in these aspects of fishery management.

I am sure that this Symposium has been beneficial in bringing together these two groups who share the difficulty of trying to draw conclusions without adequate information. I hope it has allowed them to compare their problems, to devise ways of improving their situations and to increase their understanding of one another so that co-operation between them—which, in my opinion, is absolutely essential to effective management—is developed to a higher degree. I hope that this has been the case, and that the provocative statements during the Symposium and during the summary may increase our efforts.

It has been suggested that there should be another symposium. We don't have plans for one at the moment, but, nevertheless, it might be well if a similar gathering did take place somewhere to bring such a group together. Perhaps then, we will have a bit more light on both the biological and the economic aspects of the sport fisheries. In the meantime, the problem remains with us, and the poor administrator is left carrying on with inadequate analysis of the situation. One of the difficulties of having inadequate knowledge is that it is impossible to combat the unreasonable and emotional approach which so often is made, as well as we should.

Before closing this Symposium I would like to express the thanks of my Department for the participation of so many people who came here from a great distance, from south of the border, from the provinces and the universities. We really appreciate your participation—especially those who gave papers and who led the panel discussions. I also wish that Mr. Rutherford, who did so much of the work of organization, had been able to be here to see the fruit of his labours.

So we come to the end of what I think has been an interesting and profitable gathering. Again with thanks to you, and with best hopes for the future of the economic and biological assessment of the sport fisheries, I bring this Symposium to a close.

APPENDIX A

SECRETARIAT*

General Secretary

J. B. RUTHERFORD

Fisheries Research Board Liaison

J. A. ROGERS

Administration

M. R. GILMORE

Administrative Staff

J. P. CHARRON
MISS S. A. HAMMELL
MISS M. C. B. LEFEBVRE
MISS E. B. LENNON
MISS R. PUCCIO
MRS. M. WEISBORD

Technical

R. A. SPARGO

Rapporteurs

E. W. BURRIDGE
M. C. CORMIER
A. M. FLEMING
G. C. GIRARD

Publicity Service

J. KINLOCH
F. A. BOULDEN
MISS M. E. WOOTON

* *Except for Messrs. Rogers and Fleming of the staff of the Fisheries Research Board of Canada, all are employed with the Department of Fisheries of Canada.*

APPENDIX B

List of Registered Participants

ALLEN, K. R.,
Biological Station,
Fisheries Research Board
of Canada,
Nanaimo, B.C.

ANDERSON, WALTON J.,
Director of Research,
Agricultural Economics
Research Council of Canada,
Carleton University,
Ottawa 1, Ontario,

ANDREWS, G. W.,
Assistant Director,
Industry Division,
Dominion Bureau of Statistics,
Ottawa, Ontario.

BENSON, D. A.,
Biometrician,
Canadian Wildlife Service,
Department of Northern
Affairs and National Resources,
Ottawa, Ontario.

BENSON, W. A.,
Wildlife Land Inventory
Co-ordinator,
ARDA, Canada Land Inventory,
Department of Forestry,
Ottawa, Ontario.

BOUCHARD, PAUL,
Quebec Department of Tourism,
Fish and Game,
Quebec, P.Q.

BROOKS, L.,
Chief, Planning Section,
National Parks Branch,
Department of Northern Affairs
and National Resources,
Ottawa, Ontario.

BURRIDGE, E. W.,
Chief, Fish Culture,
Department of Fisheries of Canada,
Ottawa, Ontario.

CAMPBELL, B. A.,
Chief, Economics Branch (Pacific),
Department of Fisheries of Canada,
Vancouver, B.C.

CARTON, J. G.,
Departmental Solicitor,
Legal Services,
Department of Fisheries of Canada,
Ottawa, Ontario.

CLAY, C. H.,
Chief Engineer, Pacific Area,
Department of Fisheries of Canada,
Vancouver, B.C.

CORBEIL, ETIENNE H. (DR.),
Quebec Department of Industry
and Commerce,
Quebec, P.Q.

CÔTÉ, E. A.,
Deputy Minister,
Department of Northern Affairs
and National Resources,
Ottawa, Ontario.

COULDWELL, G. E.,
Director of Fisheries,
Saskatchewan Department of
Natural Resources,
Prince Albert, Saskatchewan.

COURTEMANCHE, ALBERT,
Biologist,
Quebec Department of Tourism,
Fish and Game,
Montreal, P.Q.

DAWSON, JOHN A.,
Economic Council of Canada,
P.O. Box 27,
Ottawa, Ontario.

FRANCIS, G. R.,
Research Associate,
Canadian Council of Resource
Ministers,
Montreal, Quebec.

GORDON, SCOTT (PROF.),
Department of Economics,
Carleton University,
Ottawa, Ontario.

HAVILAND, WILLIAM E., (DR.),
Canadian Pulp and Paper
Association,
Montreal, P.Q.

HAYES, F. R. (DR.),
Chairman,
Fisheries Research Board
of Canada,
Ottawa, Ontario.

HOURSTON, W. R.,
Area Director of Fisheries
(Pacific),
Department of Fisheries of Canada,
Vancouver, B.C.

KERSWILL, C. J. (DR.),
Director, Arctic Biological Station,
Fisheries Research Board
of Canada,
Ste. Anne de Bellevue, P.Q.

KNETSH, J. L. (DR.),
Resources for the Future Inc.,
Washington, D.C.
U.S.A.

LARKIN, P. A. (DR.),
Director, Biological Station,
Fisheries Research Board of
Canada,
Nanaimo, B.C.

LEGENDRE, VIANNEY,
Director,
Research Division, Wildlife Service,
Quebec Department of Tourism,
Fish and Game,
Montreal, P.Q.

LEMIEUX, LOUIS, (DR.),
Director, Wildlife Service,
Quebec Department of Tourism,
Fish and Game,
Quebec, P.Q.

LOGIE, R. R. (DR.),*
Chief, Fish Culture Development Branch (Maritimes),
Department of Fisheries of Canada,
Halifax, N.S.

LUCAS, K. C.,
Assistant Director, Pacific Area,
Department of Fisheries of Canada,
Vancouver, B.C.

MCCONNELL, M. P.,
Head, Industrial Promotion Section,
Department of Northern Affairs and National Resources,
Ottawa, Ontario.

MCLAREN, ROBERT E.
Chief, Fish Culture Development Branch,
Department of Fisheries of Canada,
Vancouver, B.C.

MCMYNN, R. G.,
British Columbia Department of Recreation and Conservation,
Fish and Game Branch,
Victoria, B.C.

MOFFET, JAMES (DR.),
Director,
Bureau of Commercial Fisheries Laboratory,
U.S. Department of the Interior,
Ann Arbor, Michigan,
U.S.A.

MORSE, NORMAN H. (DR.),
Head, Department of Economics and Sociology,
Acadia University,
Wolfville, N.S.

MUNRO, D. A. (DR.),
Chief, Canadian Wildlife Service,
National Parks Branch,
Department of Northern Affairs and National Resources,
Ottawa, Ontario.

NEEDLER, A. W. H. (DR.),
Deputy Minister,
Department of Fisheries of Canada,
Ottawa, Ontario.

NORTHCOTE, T. G. (DR.),
c/o Institute of Fisheries,
Fish and Game Branch,
British Columbia Department of Recreation and Conservation,
University of British Columbia,
Vancouver, B.C.

PAETZ, MARTIN,
Fish and Wildlife,
Alberta Department of Lands and Forest
Natural Resources Building,
Edmonton, Alberta.

PELLETIER, A. T.,
Director, Fish and Wildlife Branch,
New Brunswick Department of Lands and Mines,
Fredericton, N.B.

**Present address and title: Assistant-Deputy Minister of Fisheries (Operations), Department of Fisheries of Canada, Ottawa, Ont.*

PRITCHARD, A. L. (DR.),
Director, Conservation and Development Service,
Department of Fisheries of Canada,
Ottawa, Ontario

RAMESBOTTOM, J. L.,
Chief, Travel Statistics Unit,
Dominion Bureau of Statistics,
Ottawa, Ontario.

SCOTT, A. D. (PROF.),
Department of Economics, University of British Columbia,
Vancouver, B.C.

SEGUIN, RICHARD L.,
Quebec Wildlife Service,
250 St. Joseph Blvd.,
Hull, P.Q.

SINCLAIR, SOL (DR.),
Head, Department of Agricultural Economics and Farm Management,
University of Manitoba,
Winnipeg, Manitoba.

SMITH, M. W. (DR.),
Biological Station,
Fisheries Research Board of Canada,
St. Andrews, N.B.

SPARGO, R. A.,
Economics Service,
Department of Fisheries of Canada,
Ottawa, Ontario.

STOLTING, WALTER,
Staff Assistant—Economics,
Bureau of Commercial Fisheries,
U.S. Department of the Interior,
Washington, D.C., U.S.A.

TAYLOR, V. R.,
Chief, Fish Culture Development,
(Nfld. Area),
Department of Fisheries of Canada,
St. John's, Nfld.

TUOMI, A. L. W.,*
Research Economist,
Department of Fisheries of Canada,
Vancouver, B.C.

WALFORD, L. A. (DR.),
Director, Sandy Hook Marine Laboratory,
Bureau of Sport Fisheries and Wildlife,
U.S. Department of the Interior,
Highlands, New Jersey, U.S.A.

WEEKS, E. P. (DR.),
Executive Director,
Atlantic Development Board,
Ottawa, Ontario.

WHITE, WILLIAM M.,
Chief, Division of River Basin Studies,
Bureau of Sport Fisheries and Wildlife,
Fish and Wildlife Service,
U.S. Department of the Interior,
Washington, D.C.

YOUNG, DAVID A.,
Senior Economist,
Manitoba Department of Mines and Natural Resources,
Winnipeg, Manitoba.

* *Present address: Department of Fisheries of Canada, Ottawa, Ont.*