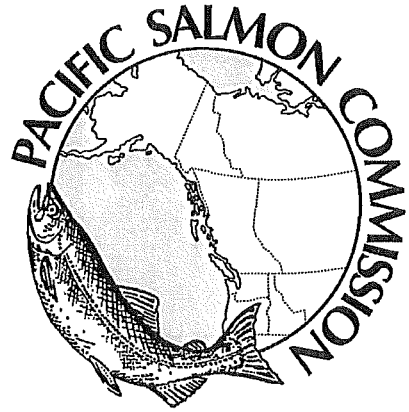
Technical Information Requirements for Effective Implementation of the Canada/United States Treaty Concerning Pacific Salmon

Natural Resources Consultants

October 1986



Pacific Salmon Commission
Technical Report No. 1

The Pacific Salmon Commission is charged with the implementation of the Pacific Salmon Treaty, which was signed by Canada and the United States in 1985. The focus of the agreement are salmon stocks that originate in one country and are subject to interception by the other country. The objectives of the Treaty are to 1) conserve the five species of Pacific salmon in order to achieve optimum production, and 2) to divide the harvests so each country reaps the benefits of its investment in salmon management.

Technical Reports of the Pacific Salmon Commission present results of completed or ongoing investigations carried out by the Pacific Salmon Commission that are deemed of sufficient interest to be made available to the scientific community and the public.

Pacific Salmon Commission
600 - 1155 Robson Street
Vancouver, B.C.
V6E 1B5
(604) 684-8081

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Prepared by:

Natural Resources Consultants

Prepared for:

Pacific Salmon Commission

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NRC
NATURAL RESOURCES CONSULTANTS

4055 21ST AVENUE WEST
SEATTLE, WASHINGTON 98199, U.S.A.
(206) 285-3480

TECHNICAL INFORMATION REQUIREMENTS FOR EFFECTIVE IMPLEMENTATION OF THE CANADA/UNITED STATES TREATY CONCERNING PACIFIC SALMON

Prepared For:

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EXECUTIVE SUMMARY

From mid-July through August 1986, the consultants studied official documents and interviewed over 40 Canadian and United States technical specialists and officers associated with the work of the Pacific Salmon Commission as background for preparation of the present report dealing with information requirements of the Canada/United States Treaty on Pacific Salmon. In their report, the consultants have been required to identify the technical information needed to:

- Meet the Parties' Treaty obligations.
- Permit the Parties to benefit to the maximum extent possible from the Treaty's provision.
- Identify opportunities for cooperative research and data sharing between the Parties.
- Identify any time constraints on information collection.

In addition, at its September 18-19 meeting, the Research and Statistics Committee requested the consultants to provide some supplementary views. The following summary covers points made both in the main report and in the consultants' supplementary submissions.

The Treaty deals with salmon stocks vulnerable to fishing by both countries with the objectives of preventing over-exploitation, providing for optimum production and equitable sharing. The Parties are required to develop fishing plans and to coordinate enhancement programs in a manner consistent with the objectives. To accomplish the latter, information is required

for four broad purposes (arranged below in the temporal order in which information is generally required).

- Forecasting and pre-season preparation of fishing and enhancement plans;
- In-season control of fisheries;
- Post-season measurement of performance;
- Determination of harvesting and enhancement targets to achieve the objectives of the Treaty.

Work required for the first three purposes tends to be shorter term than that required to facilitate achievement of the broad objectives of the Treaty. These short-term aspects are rather fully spelled out in the Treaty and its associated background documents. Provision for information of this type is clearly obligatory on the Parties and usually must be provided within rather tight time limits. The more general work aimed at providing the basis for setting targets, represents a much more long-term activity involving development of understandings of factors that affect productivity. Not only are the activities likely to be longer term, they are also likely to lie much more in the preserve of national programs than within the ambit of cooperative work within the Commission.

Up to the present, by far the greatest emphasis has been placed on the determination of the rivers of origin of salmon. Currently, enumeration of escapements (particularly developing index systems) is also accorded importance but at a substantially lower level than stock "ID" work. Studies on the important

question of determining the productivity of the stocks remain almost entirely at a national level.

In considering the specific informational needs of the Commission the authors examined institutional issues and technological needs as well as specific research activities. The report and its appendices discuss these matters in some detail and the authors make the following observations and suggestions.

1. At the present time, research activities under the Commission are focused in numerous individual technical committees. There is no overall outline of the research issues that are being addressed and no comprehensive cross-species cross-area, cross-committee review of the adequacy of present research efforts.

2. The Commission has not established specific long-term objectives for its activities and most effort within the Commission has been directed to the ad hoc job of implementing annual fishing regimes and in preparing to negotiate new short-term arrangements.

3. Under such circumstances it is premature to develop a specific long-term plan.

4. Instead it is recommended that the Commission undertake a two-pronged approach to lay the groundwork for long-term planning involving:

- Undertaking a review summarizing available information on the distribution of stocks among fishing areas, the extent of removals and the abundance of escape-

ments; such information to be related to the short-term requirements of the Treaty regarding the elaboration and implementation of fishing and enhancement plans.

- Initiation of cooperative work to develop a list options for future long-term management and development programs and to assess the implication of such programs with respect to the Treaty.

5. On the basis of information from the foregoing, long-term research questions can be identified and planning of a long-term research program planned.

6. The Research and Statistics Committee should be the focus for the research review proposed above. To facilitate the review and to provide generally for better coordination of research activities within the Commission, steps should be taken to ensure active participation of representatives of the Technical Committees in the work of the Research and Statistics Committee.

7. Efforts to standardize formats, to develop computerized data exchange systems and to evaluate the quality of catch data (coordinated through the Statistics and Research Committee) would seem worthwhile. An outgrowth of these efforts should be the development of an information system which allows for ready access to standardized catch and effort data sets which can be easily equated to each other.

8. As part of the review referred to in item 4 above, it would timely for the governments and the Commission to spend some

time and effort conducting an overall review of stock ID technology and of the effectiveness of present approaches, with a view to:

- Examining stock ID methods in terms of their assumptions, analytical techniques and sampling systems which facilitate stock composition estimates.
- Providing background to assist each government in making choices in stock ID programs;
- Identifying opportunities for cooperation between agencies in the standardization of techniques and in the development of new techniques;
- Identifying situations where there are needs for closer coordination between agencies in the planning and conduct of stock ID programs.
- Identifying areas in which stock ID information is needed on a priority basis.

9. Little work is being done that is directly aimed at gaining more precise knowledge of productivity and of the related subject of the effects of escapement levels on production.

10. It would seem appropriate for the Commission to give consideration to research on productivity and to seek opportunities for technical cooperation in this field between agencies in the two countries. It might be useful to convene a meeting of technical specialists to examine the existing state of knowledge on factors affecting the abundance of salmon and on research

required to gain a better understanding of the production process.

11. The scientists of the two countries should consolidate their efforts to develop comparable and improved techniques for spawning escapement enumerations and to thoroughly evaluate the utility of index system approaches.

12. It may be of value for scientists in the two countries to consider cooperative analyses and exchanges of old statistical data to determine their utility for studying productivity of relevant stocks over the long term.

13. With respect to current enhancement activity, there is an urgent need to initiate and set in place a system for careful performance evaluation including the development of an appropriate information system to assess future enhancement strategies. Work to determine the reasons for success or failure of existing facilities and to improve the productivity of artificial propagation facilities, e.g. disease control, diet, genetic management and determination of optimum conditions for release should be expanded.

14. An ad hoc group including some Commissioners, panel members and technical specialists should be convened to make recommendations aimed at improving the timing of information exchanges, and of meetings of technical committees, panels and the Commission should be established. Evaluations leading to such recommendations should weigh most carefully the trade-offs

between precision and completeness of data on the one hand and administrative efficiency on the other.

15. As mentioned above in dealing with individual subjects (e.g. stock ID and escapement enumeration), the consultants feel that special and urgent efforts should be made to develop standard approaches to reporting and use of techniques for all the Commission's research work with a view to improving the overall quality of the work and to resolving remaining differences between technical specialists of the two sides.

16. The Commissioners will be under considerable pressure to "hold the line" on spending. Nevertheless, they should make every effort to keep the respective governments fully aware of the funding requirements needed to meet the conservation and production commitments subscribed to by the parties. In this sense, a full scoping of the longer term enhancement requirements--either natural or artificial--and potential benefits resulting from such funding should be undertaken. We doubt there is enough money in the current national budgets concerned with the PSC to fully meet Treaty obligations and thus reap the benefits of increased production and the vital public support that would follow.

TECHNICAL INFORMATION REQUIREMENTS FOR EFFECTIVE IMPLEMENTATION OF THE CANADA/UNITED STATES TREATY CONCERNING PACIFIC SALMON

1. INTRODUCTION

In January 1985, the Governments of Canada and the United States concluded a comprehensive Pacific Salmon Treaty. The Pacific Salmon Commission (PSC), established under the terms of the Treaty, is required to facilitate management, cooperative planning and enhancement programs of salmon resources of mutual concern. In brief, the Treaty deals with salmon resources vulnerable to fisheries of both countries with the objectives of avoiding over exploitation, providing for optimum production and for sharing of harvests so that each Party receives benefits equivalent to its own production. The planning and monitoring of salmon fisheries and stocks throughout much of the Pacific Northwest and the resolution of past differences (between the Parties) in technical interpretations on the origins of salmon in certain areas will require extensive research, as well as collection, exchange and analysis of statistical material.

The Treaty outlines the general nature and scope of research and information required of the Parties, but, with certain exceptions, does not identify or assign priorities to the specific investigations to be undertaken. Planning of such research is left to the Parties, working cooperatively within the consultative framework of the new Commission.

The first year and a half of the Commission's existence has been a hectic period for officials and private sector advisors on

both sides. The putting in place of the Commission's Panels, Standing Committees, technical committees, working parties, sub-committees, development of procedures for consultation and information exchange and implementation of the general fishing plans laid down in the Annexes of the Treaty for the 1985 and 1986 fishing seasons have severely taxed the capacities of the management agencies involved. It is not surprising, therefore, that during this initial period, attention has been focused on administrative and short-term research aspects of the Treaty and that long-term information needs of the Commission have been postponed for later consideration.

After an absence of almost four years from international deliberations on Canada/United States salmon problems, the consultants were impressed with the strides that people on both sides (fishermen, processors, research workers and administrators) have made on building trust and cooperation within the framework of the new Commission. The consultants would like to thank the officers of the Commission and members of agencies who took time to provide their views and advice to the consultants. The hurried pace of the consultations obviously left many aspects of research untouched. It is hoped, however, that discussions begun now will reach fruition in future deliberations of the new Commission.

Despite the Commission's concentration on short-term issues, the Commission recognized a need to initiate planning of longer-term needs for research and information collection and exchange.

In order to expedite planning in this field without further burdening the hard-pressed technical staffs of the two countries, the Commission contracted with Dr. D. L. Alverson and Dr. M. P. Shepard through Natural Resources Consultants of Seattle, to provide a preliminary appraisal of both the short and long-term requirements of the Treaty.

1.1 The Task

The study was initiated in late July 1986 following a meeting between the consultants, the Executive Secretary of PSC and representatives of the two Governments (See Appendix 1 for list of participants). The meeting served to develop a statement of work and a work schedule, and to identify individuals that the consultants would be requested to interview during the course of their study. The Statement of Work to be performed by the consultants was as follows:

1. "Review Pacific Salmon Treaty articles, annexes and memorandum of understanding with a view toward identifying the technical information needed in the short and long-term implementation of the Treaty.
2. Identify the technical information needed to:
   A. Meet the Parties' Treaty obligations.
   B. Permit the Parties to benefit to the maximum extent possible from the Treaty's provision.
   C. Identify opportunities for cooperative research and data sharing between the Parties.

D. Identify any time constraints on information collection.

The consultants were required to consult with each Commissioner or his designee(s), the Co-chair of each panel, and the Co-chairs of each technical committee. Their report was to be submitted to the Chair of the Research and Statistics Committee and to the Executive Secretary by September 12, 1986. It was understood that a draft report would be submitted subject to revisions based on suggestions from the Committee. Such revisions, along with the consultants' reflections on primary results and actions required by the Commission to effectively carry out its mandates (Appendices 3 and 4), have been incorporated into this final report.

Documents reviewed by the consultants included the January 28, 1985 Canada/United States Treaty with associated annexes and memoranda of understanding between the Governments, reports of all the Commission's committees, sub-committees and working parties and a number of historical documents associated with negotiation of the Treaty (see Appendix 2).

As listed in Appendix 1, interviews were carried out in Seattle, Washington (July 11 and 29 and August 1 and 28), Olympia, Washington (July 30), Portland, Oregon (July 31, Vancouver and New Westminster, B.C. (August 12, Nanaimo, B.C. (August 13, Juneau, Alaska (August 21) and Prince Rupert, B.C. (August 22). The consultants reviewed their preliminary report

with the Research and Statistics Committee in Richmond, B.C. on September 18, 1986.

Following this introduction section, the report is divided into four segments.

The following segment (Section 2) provides the consultants' interpretation of the information requirements flowing from the Treaty and its associated documents.

Section 3 provides an account of past research relevant to the objectives of the present Treaty and a brief characterization of research currently under review by the new Commission. The latter provides an insight into current views on information requirements.

Section 4 attempts to relate the various types of information required for implementation of the Treaty to specific short and long-term objectives of the Treaty. The content of this section will undoubtedly appear to be overly simplistic to technical specialists and will disappoint those expecting the report to represent a clear-cut and very specific blueprint for a future research program. There are two reasons for having taken such a general approach. The first is lack of time; it is apparent that with only about a month of working time to complete the project, about half of which was spent travelling to interview officials, it was not possible to conduct an in-depth appraisal of the many complex research issues facing technical specialists in both countries. A second reason for dealing at the level of generalities was that the consultants were informed

that they were not expected to comment on individual research projects or to attempt to assess priorities among existing projects. They were also requested to avoid discussion of national research-related activities that might not properly be viewed as falling within the purview of the Commission. Despite the fact that the presentation in this section is very general, it is hoped that it will at least provide a checklist which could serve as a guide for bilateral or internal domestic consideration of research and information requirements.

The consultants feel that the efficiency and quality of the Commission's consideration of research will depend to a considerable extent on the mechanisms the organization developed to deal with the subject; good research planning is unlikely to develop unless an orderly approach is developed for appraising (either collectively or within each national section) ongoing research and for identifying and prioritizing remaining needs. For this reason, although not required specifically to do so by their Statement of Work, the consultants have given scrutiny to the question of institutional arrangements within the Commission for appraisal and planning of research (Section 5).

Appendix 2 provides historical background on the history of the negotiation of the Treaty. Appendices 3 and 4 provide personal views of each of the consultants on important measures required for effective future planning of research.

2. TREATY OBLIGATIONS WITH RESPECT TO INFORMATION

It is evident from a reading of the Treaty and of its supporting documents that both Parties recognize that achievement of the objectives of the Treaty and resolution of past conflicts over levels of interceptions can only be achieved by substantial commitments by the Parties to research, data collection and information exchange.

The importance of research is first noted in the Preamble to the Treaty which mentions the desire of the two Parties "... to cooperate in the management, research and enhancement of Pacific salmon stocks ..." (emphasis added).

2.1 Basic Principles

The basic principles of the Treaty, as outlined in paragraph 1 of Article III are to:

- Prevent over-fishing and to provide for optimum production; and,
- Provide for each party to receive benefits equivalent to the production of salmon originating in its rivers.

The ability of the Parties to achieve these objectives clearly depends on possessing comprehensive understandings of factors influencing salmon production coupled with the capability to manage salmon fisheries in a manner which meets spawning escapement needs and allocates the harvest in an equitable way. For stocks subject to the Treaty, such management requires knowledge of run sizes, stock composition, distribution of stocks

among fishing areas, and timing and migration routes of adults returning through the fishing areas.

Paragraph 2 of Article III makes it mandatory for the Parties to cooperate in management, research and enhancement. The paragraph, however, does not specify the nature of such cooperation, although further details regarding these commitments are spelled out in Articles IV-X.

2.2 Monitoring

Paragraphs 1 and 2 of Article IV of the Treaty cover post-season monitoring of fisheries to assess whether or not their conduct had been in conformity with the Treaty. Paragraph 1 of that article requires each Party to provide to the other Party and to the Commission an annual report of its fishing activities in the previous year while paragraph 2 specifies that relevant panels of the Commission review such reports and provide their views to the Commission which, in turn would express its views to the Party submitting the information.

2.3 Preparation of Fishing Plans

A critical function of the Commission is to act as a focus for planning of each season's fishing activities in fisheries relevant to the Treaty. Paragraph 3 of Article IV provides for the state of origin to provide preliminary information regarding salmon runs in the ensuing year including information on:

- The estimated size of the run;
- The spawning escapement required;
- The interrelationship between stocks;

- The estimated total allowable catch;
- Its (the State of origin's) intentions concerning fisheries in its own waters; and,
- Its domestic allocation objectives whenever appropriate.

On the basis of information provided by the Parties, the Commission (after deliberation of the issues within its Panels) is required to recommend "fisheries regimes" (defined as "fishing limitations and arrangements adopted by the Parties ...") to the Parties. On adoption by both Parties, each Party assumes the obligation to establish and enforce regulations to implement such regimes.

2.4 Cooperation on Enhancement

Information exchanges are also required with respect to cooperation in enhancement. Paragraph 2 of Article V requires the Parties annually to provide information on:

- Operations of and plans for existing enhancement projects;
- Plans for new projects; and,
- Views on the other Party's enhancement projects.

Such information is to be reviewed by the Panels and by the Commission which makes its views known to the Parties and which also may make recommendations to the Parties regarding their programs (paragraphs 3 and 4 of the Article).

2.5 Direct Obligations Regarding Research

Article X deals specifically with research needs to support the Commission's objectives. With respect to stocks

covered by the Treaty, the Article calls specifically for the Parties to conduct research to investigate:

- Migratory and exploitation patterns;
- Productivity;
- Status; and,
- Extent of interceptions.

Paragraph 2 of the Article makes it permissible for the Commission to make recommendations "regarding the conduct and coordination of research."

Although Article X is the principle article dealing with research, the organization of research and specification of information gathering activities permeate the remainder of the agreement. Thus, paragraph 17 of Article II establishes a Research and Statistics Committee. Article XII establishes a technical dispute settlement mechanism while Article XIV deals with implementation of the Treaty, requiring each Party to provide "... reports from its nationals and vessels of catch, effort and related data for all stocks ..." subject to the Treaty. The latter article also provides for exchanges of "... fisheries statistics and any other relevant information on a current and regular basis in order to facilitate the implementation ..." of the Treaty.

The emphasis on technical exchanges is further elaborated in the Memorandum of Understanding between the two governments. A significant portion of the memorandum under the heading "data sharing" concerns itself with technical methodology, stock

identification, escapement enumeration, resource forecasting, stock productivity and estimation of interception rates. In reality, the memorandum treatment of "data exchange" is a condensed outline of both short and long-term needs.

In addition, the Annexes of the Treaty contain very specific provisions regarding information collection, exchange of information and analyses. Thus Annex 4 establishes Technical Committees dealing with chinook salmon and coho salmon (both on a coast-wide basis), southern chum salmon stocks, and fisheries in transboundary rivers and the northern British Columbia/Southeast Alaska Boundary Area. For each Committee, the Annex provides terms of reference specifying information to be collected and exchanged and analyses to be conducted. The commitments vary greatly from Committee to Committee, but, as illustrated in Tables 1-3, place formidable demands on the Parties.

The Treaty gives separate treatment to fisheries for sockeye and pink salmon in the Fraser River Convention Area (Article VI) and for fisheries for all species on the Yukon River (Article VIII). For the Fraser, an exchange of letters between the Parties dated August 13, 1985 outlines the division of responsibilities for research and information provision between the Parties and the Southern Panel of the Commission with respect to Fraser-bound sockeye and pink stocks. For the Yukon, the Parties are required to consider "co-operative research programs, enhancement opportunities and exchanges of biological data."

2.6 Functional Information Categories

From the foregoing array of research commitments, the functional purposes of information collection, analysis and reporting fall roughly into four categories (arranged in the temporal order in which information is generally required):

- Forecasting and pre-season preparation of fishing plans (particularly paragraph 3 of Article IV which prescribes information that will be exchanged prior to development by the Commission of agreed fishery regimes and paragraph 2 of Article V which requires exchange of planning information related to enhancement);

- In-season control of fisheries. Information required to tailor fishing effort during fishing seasons to agreed-upon levels of catch or effort;

- Post-season measurement of performance. Information exchanged between the Parties and the Commission required to permit assessment of the extent to which activities of the Parties (with respect to both fishing and enhancement) have been conducted in accordance with the terms of the Treaty (e.g., paragraphs 2 and 3 of Article IV and paragraphs 3 and 4 of Article V; and,

- Establishment of harvesting and enhancement targets to achieve the objectives of the Treaty as outlined in Article III, namely prevention of over-fishing, provision for optimum production and equitable division of benefits.

Work required to serve the first three functions tends to be shorter term than required to facilitate achievement of the broad

objectives of the Treaty. To a considerable extent the provision of information on run expectations and post-season reporting of harvests in different fisheries is rather fully spelled out in the Treaty and its associated background documents. From this point of view, provision of information of this type is clearly obligatory on the Parties and such information usually must be provided within rather tight time limits. Measurements of harvest and determination of the rivers of origin are the most important data required for these short-term purposes.

In general, the fourth function, determining the basis for setting targets, represents a much more long-term activity. Establishing appropriate conservation measures to avoid over-exploitation and to promote "optimum utilization" requires development of understandings of basic factors that effect productivity; relationships between abundance of spawners and resultant returns, environmental limitations, etc. Studies of productivity clearly represent a much more complex field of endeavour than the collection and analysis of information associated with the development and monitoring of short-term seasonal fishing plans. Not only are the activities likely to be longer term, they are also likely to lie much more in the preserve of national programs than within the ambit of cooperative work within the Commission. thus, although certain aspects of their determinations may be subject to technical dispute settlement under Article XII of the Treaty, the State of origin alone has the responsibility for setting escapement targets and

for the conduct of enhancement on all rivers other than the Transboundary Rivers where the responsibility is shared. It is also evident that concepts of "optimization" are very likely to differ between the Parties because of national differences in economic and social objectives and in administrative systems. These factors create uncertainty with respect to the extent that such long-term research related to the productivity of the stocks should be considered as an appropriate function for cooperation within the new Commission.

With the foregoing general background, the next section of the report briefly summarizes past research activities relevant to the implementation of the Treaty. The section following gives detailed consideration to the individual elements of information that are required to meet the needs of the four types of activities listed above.

3. PAST AND CURRENT RESEARCH ACTIVITIES RELATED TO THE TREATY

3.1 Pre-Treaty Activities

In negotiating the Treaty the Parties depended on a body of research findings that had been developed by national research agencies in both countries, the International Pacific Salmon Fisheries Commission (IPSFC), the International North Pacific Fisheries commission (INPFC), and more informally through the Pacific Marine Fisheries Commission (PMFC). Information resulting from bilateral research arrangements (e.g., tagging and recovery programs in the northern British Columbia and southeast Alaska area over the past five years) also aided the negotiators.

Information concerned with the identify and quantity of interceptions of salmon bound for rivers of one country by fishermen of the other was an important element in the evolution of the Treaty. Thus data concerned with catches in key areas where interceptions occurred and on the origin of salmon found in those areas was a central issue in developing initial fishing regimes.

Stock identification and levels of interceptions were of major research interest to the negotiating Parties. For the important sockeye runs of the Fraser, beginning in the late 1930's, the IPSFC conducted tagging and studies of scale characteristics to determine the migration patterns of the different races of sockeye passing through the Fraser convention area. In recent years, through cooperation between the IPSFC and national

authorities, the scale studies were extended to include Johnstone Strait, troll fishing areas off the British Columbia coast and outer net fishing areas in northern British Columbia and southeast Alaska. These studies greatly improved knowledge of the contribution of individual stocks to the fisheries of the region.

With respect to chinook and coho salmon, sporadic marine tagging experiments were conducted in British Columbia, Washington and Alaska from the 1920's through the 1950's. These experiments revealed extensive intermingling of United States and Canadian chinooks along the coasts of Washington, British Columbia and Southeast Alaska, as well as significant but less extensive intermingling of coho.

In the 1940's through the 1960's, as part of domestic management programs, both countries tagged sockeye, pinks and chums in other areas than on the approaches to the Fraser. Important studies included: (a) taggings of pinks and chums in Johnstone Strait (1945 and 1953), (b) sockeye and pink salmon off the west coast of Prince of Wales Island (1957 and 1958), (c) at the entrance to Portland Canal and off the mouth of the Skeena in 1957 and 1958, (d) movements of coho salmon at the entrance to the Strait of Juan de Fuca in 1958, (e) a comprehensive tagging escapement survey conducted cooperatively between IPSFC, Washington State Department of Fish and Game and the Canadian Department of Fisheries in waters throughout southern British Columbia and northern Washington in 1959 and 1961 and (f) a Canadian tagging of all species of salmon in Dixon Entrance in

1967 and 1968. These studies provided a general perspective of the migrating patterns of many important stocks from southeast Alaska southward to northern Puget Sound.

Mainly during the 1960's through a cooperative INPFC program, Canadian, Japanese and United States scientists conducted extensive studies of the high seas distribution of salmon throughout the North Pacific. This work, including tagging, studies of parasite infestation, counts and measurements of body parts, scale patterns and protein chemistry yielded information on the offshore distribution of salmon that provided insight into migratory movements of stocks subject to interception by foreign fishermen as well as Canadian and United States fishermen.

With the growth of hatchery programs in the United States in the 1960's, fishery agencies in the northwest states began marking large numbers of young fish through removal of fins. Coupled with sampling of major fishing areas, the programs were aimed mainly at assessing the survival and contribution of hatchery fish to the fisheries. The work was coordinated through PMFC with Canadian participation being provided through an "informal" Canada/United States Committee on Chinook and Coho.

By the early 1970's, tagging young fish through implantation of coded-wire tags supplanted the earlier fin marking programs. Work in this field has expanded over the years and now constitutes one of the major tools for evaluating the production and migration of fish produced in enhancement facilities in both the United States and Canada. The planning and conduct of coded-

wire tagging programs is presently a major topic for consideration by the new Commission.

In addition to coded-wire tagging, marine tagging programs and racial studies involving evaluations of scale patterns and generic electrophoretic techniques has been developed by the scientists of both countries to improve the basis for determining the origin of salmon in the fisheries.

In the late 1960's, in order to overcome increasing competitive international fishing for salmon (see Appendix 2), the two governments began to explore the possibility of developing a comprehensive coast-wide agreement to control salmon interceptions. As a possible basis for an understanding, they considered agreeing to limit intercepting fisheries on both sides in a manner that would result in the total value of interceptions on the two sides being equal. In order to examine this possibility, in 1970 they established a Technical Committee on Salmon Interceptions to attempt to develop agreed estimates of the number and weights of salmon intercepted in fisheries on a coast-wide basis.

Scientists of the two countries reviewed the mass of information that had been collected from 1970 to 1978 and prepared annual reports on their findings. The two sides were not able to agree on estimates for all fisheries and national reports therefore list independent estimates by each. Despite the fact that unanimity was not achieved, the Technical Committee's work provided an insight into the problems of quanti-

fying contributions of salmon stocks of the two countries to the various fisheries and for identifying gaps in knowledge of migrations and interceptions.

The estimates for interceptions of Fraser-bound sockeye and pinks (species covered by the old IPSFC) by the two sides were generally identical. Estimates were also relatively close for a number of other fisheries (e.g. for most fisheries for chinooks in southern British Columbia and Washington). Particular difficulties were encountered deriving interception estimates for a number of fisheries in the southeast Alaska and northern British Columbia area. The persistence of these differences led the governments to develop cooperative tagging programs in these areas beginning in 1982.

In 1970, the two governments formed a Committee on Salmon Valuations with the objective of developing common methods for placing values on salmon interceptions. The Committee was short-lived, however, when it became apparent that widely different approaches to valuation on the two sides could not be reconciled.

Other technical working groups were formed from time to time. For example, in 1981, a committee was formed to summarize information on salmon stocks originating in transboundary rivers in the southeast Alaska/northern British Columbia area. In the early 1980's, an informal technical group was formed to summarize coast-wide information on chinook stocks, and on the measures needed to rebuild them.

With the exception of chinook where technical staff cooperatively documented the deleterious changes that had occurred in the stocks, virtually all the information considered by the governments as background for development of the Treaty was concerned with determining the origin of salmon. Work on the important question of the productivity of stocks remained at a purely national level. Even at a national level, efforts to define productivity and factors affecting production have not been extensive. In recent years, fisheries administrations have typically been concerned with allocation problems and/or work on development of enhancement technology. Thus much of their efforts have been concentrated on short-term studies to better define migration routes, to estimate harvest rates and to develop better means for timely monitoring of fisheries.

3.2 Research Currently Considered by the Treaty

The reports of the Commission's various technical committees provide a convenient account of research activities considered relevant at the present time.

3.2.1 Chinook salmon

The Chinook Salmon Committee's report focused on the development of a stock rebuilding plan, a key element in the negotiation of the Treaty.

The approach taken by the Committee in recommending elements of the rebuilding plan to the Commission has been identified by a number of indicator stocks whose performance could be used to measure progress towards achieving the general objectives of the

plan. As outlined in the 1986 committee report, "... escapement indicator stocks will be the primary means to assess ... progress ... but escapement itself does not adequately describe the present abundance of a stock. Exploitation rate indicator stocks are the tool which will be used to analyze the effects of ocean management actions and in association with escapement indices can be used to estimate stock abundance."

The Committee considers two important criteria for measuring progress towards achieving the long-term objective of maximum sustainable yield; the levels of indicator stock spawning escapements compared to established goals and continued evaluation of the escapement goals themselves. Key information needs are therefore concerned with the abundance of indicator escapements and data on the contributions of such stocks to the fisheries. Coded-wire tagging has been the principal means of identifying indicator stock fish in the fisheries. Many of these stocks are either hatchery runs or runs passing through dams on a seasonal basis.

The Committee is concerned with the representativeness of currently used indicator stocks and expects to be able to expand the number of stocks included in the future. Inclusion of more natural stocks in the indicator list poses serious challenges in development of methodology for estimating escapements and in identifying fish from the selected stocks in the fisheries.

Selection of appropriate escapement targets is an important concern of the Committee. As its report notes, the escapement

targets established for the current plan were preliminary, and in many cases represented "... underestimates because they reflect interim targets given severely depressed status during the base period." Thus, means of establishing more appropriate escapement goals are an evident long-term need; information on factors affecting the basic productivity of the stocks is also needed. As the Committee's report noted:

> "Evaluations should involve measuring escapements sustained above specific targets, assessment of the accuracy of escapement goal targets in providing maximum sustainable harvest, and definition of harvest distribution patterns. The rebuilding program provides an opportunity to estimate the production potential from chinook stocks and to determine harvest strategies to sustain maximum yields. To conduct these evaluations a commitment to long-term support for tagging and escapement enumeration in index stocks is required, and a recognition that escapements must be allowed to vary for evaluation of production response."

The Committee was unable "... to carefully address recommendations for research." The group did however indicate its belief that "... the establishment of indicator stock programs must receive high priority."

3.2.2 Coho salmon

Because the spawning stocks are so broadly distributed among literally thousands of small streams, because spawning generally takes place late in the season when water levels are high, making

observation difficult, and because relatively little work has been done to identify the origin of fish taken in the fisheries, meeting treaty information requirements for coho is an especially difficult task.

The first report of the Coho Technical Committee provides an excellent review of the conduct of relevant fisheries and approach of technical questions posed to it by the Southern Panel. However, reflecting the paucity of information on coho stock abundance and migrations, a major part of the Committee's report was directed to defining research needs (a requirement in the Committee's terms of reference). The recommendations called for:

- Improvement of spawning escapement estimation techniques;
- Determination of wild stock productivity;
- Determination of stock composition for fisheries of concern;
- Establishment of an indicator stock program;
- Development and improvement of run strength forecasting and estimation techniques;
- Simulation model development.

The Committee's analysis of research requirements outlining the applicability of the information to be collected, the current state of knowledge, research in progress and brief specification of the needs, provides a useful perspective of short and longer term information needs.

4.2.3 Northern boundary fisheries

In addition to reviewing the status of relevant fisheries in the boundary area, the Northern Boundary Technical Committee provided a progress report on research in the northern area. The research section of the report covers the results of the extensive cooperative tagging programs that had been conducted on sockeye and pink salmon during 1982-1984, and the results of studies of biological markers (scale, electrophoretic and parasitic characteristics).

The report, which assesses the adequacy of present research programs but makes no recommendations, indicates that:

- For sockeye, extensive background has been obtained from the recent tagging programs. Biological markers (preferably used in combinations) have shown considerable promise for stock identification.

- For pinks, tagging remains the only reliable means for identifying stocks; annual variations make continued monitoring of pink interceptions desirable. Improved means of estimating escapements are needed, particularly in the many small streams whose aggregate contribution to the fisheries is large.

- For chum salmon, electrophoretic techniques used by scientists in both countries are being tested; CWT data are available for some enhanced stocks; an expanded tagging program is planned for 1987; improvements are being made in escapement procedures.

The Northern Boundary Committee gives consideration to regional chinook and coho stocks supplementary to that given by

the chinook and coho committees. For coho, the Northern Boundary Committee report re-emphasized the need for techniques for separating stocks and for estimating escapements. The report suggests that a pilot study be undertaken on scale patterns, electrophoretic characteristics and parasite content. A similar pilot study for chinook salmon is called for. The report notes that Canada has launched a key stream escapement enumeration program for both chinook and coho.

3.2.4 Transboundary fisheries

The first report of the Transboundary Technical Committee contains an extensive review of progress in research on transboundary stocks. Scale and parasite studies have been useful for separating out sockeye of Alaskan, Canadian transboundary and Canadian coastal origin. Age composition and egg diameter data have been useful as in-season indicators of areas of origin. Parasite content studies were being conducted on coho salmon. CWT studies of Stikine chinook provided improved information on the exploitation of some spring chinook runs in that river and on chinooks originating in the Taku. Technical personnel in the two countries were cooperating in escapement studies, including a tag and recapture program on the Taku.

In discussing enhancement opportunities, the report emphasized the need for inventories of spawning and rearing areas.

3.2.5 Statistics and Research Committee

The Commission's Standing Committee on Research and Statistics held its inaugural meeting in May 1986 and developed its

terms of reference. With respect to research planning, the Committee decided to seek consultancy assistance in identifying information needs; the present consultancy was launched as the result of this decision. The Committee also recommended that an overview plan for research be developed for approval by the Commission by September 1986 and that a standardized evaluation format be developed for reviewing ongoing programs "for relevance to Canada/United States Treaty issues."

3.2.6 Technical Committee on Data Sharing

The Memorandum of Understanding that accompanied signature of the Treaty established a working group to review the extensive coded-wire tagging and recovery program being conducted by agencies in both countries. A data sharing committee (working under the umbrella of the Statistics and Research Committee) met at the end of April, 1986, to begin its work. Separate working groups, one dealing with mark recovery data bases and the other with mark recovery analytical methodology were established. The former group identified the establishment of a common data set and of a set of protocols and standards for handling data input as being immediate needs. The second group plans to concentrate on developing "parameters to be estimated, estimating procedures, how to estimate variances about the estimates and statistical tests to compare the estimates."

The Committee is required to submit a final report by April 1, 1987.

3.2.7 Assessment

From the foregoing, it is apparent that stock identification is accorded by far the greatest priority by the Parties in the conduct of research in support of the Treaty. Enumeration of escapements (particularly developing index systems) was also accorded importance but at a substantially lower level than stock "ID" work. Work on basic productivity was recognized as a need but was not being featured significantly in current research programs under review by the Commission.

3.3 National Research Programs Not Considered by the Commission

In the short time available to them, the consultants did not have the opportunity to review salmon research programs being conducted by national agencies on both sides which were not being considered by the Commission. Some such activities could well have relevance to the Commission's objectives, particularly those related to the assessment of productivity. For example, work related to the effects of lake fertilization on production could have important implications for future cooperative activities and for learning more about factors limiting production under natural conditions as background for setting escapement and production targets. This subject is given further consideration in the final section of the report.

4. SPECIFIC INFORMATION NEEDS

It will be recalled that, in Section 3, it was concluded that information for implementation of the Treaty was required for four general purposes. The first three comprised the relatively short-term purposes of pre-season planning, in-season control and post-season monitoring of fishing and enhancement activities. Work directed towards the latter purposes is specifically mandated and rather fully elaborated within the Treaty and its associated documents. The fourth purpose, determination of harvesting and enhancement targets (associated with the Treaty obligations to prevent over-exploitation and to provide for optimum production) tended to be of a longer-term nature and not as clearly and precisely specified in the Treaty.

The previous section of this report revealed that the greatest part of the research effort expended by the Parties in the past is devoted to meeting the needs of the first three, short-term purposes. The present Section attempts to outline the types of information and/or research that is required for all four purposes. As is noted below, many types of information may be required to meet the needs of more than one purpose.

It is perhaps easiest to relate individual types of data to the purposes for which they are required by construction of a matrix. Table 4 (included at the end of the report) represents an attempt in this direction. Each column of the table indicates the types of data required to meet the Treaty needs for each of the four purposes listed in the first paragraph above. Each row

specifies a type of data (e.g., measurements of harvest, etc.). The specific information needs have been divided into four functional categories, information on harvesting, on factors influencing resource abundance, on factors affecting resource availability and on enhancement. These divisions are somewhat artificial and they are not mutually exclusive. The tabulation nevertheless provides a basic checklist. The types of information required and the relevance of each to the four basic purposes identified within the Treaty is discussed below.

4.1 Harvesting

4.1.1 Measures of removals (numbers of fish by species, areas and times)

Measures of the gross harvest of salmon stocks covered by the Treaty represent the single-most important set of data required for its implementation. With respect to conduct of fisheries by the Parties (commercial, recreational and subsistence) in the initial stages of the Treaty, past levels of catches in intercepting fisheries or complexes of fisheries were key to establishing agreed target levels for the fisheries specified in Annex 4 of the Treaty. Monitoring the performance of the Parties during the first two years of the Treaty in large measure has involved the comparison of actual catches (in terms of number of fish) with target levels established in Annex 4 of the Treaty. Records of gross catches by species, areas, gears and season therefore are an essential part of forecasting and pre-season planning for the control of fishing under agreed terms

as well as for post-season assessment of the performance of the Parties in meeting their obligations under the Treaty.

Catches (apportioned among the stocks contributing to the fisheries), are of course the basic measure of productivity of the stocks and of the contributions of each country to the total production of salmon covered by the Treaty.

Since the 1950's, fisheries management agencies in both countries have developed comprehensive statistical systems providing breakdown of catch by species, areas and times, attuned to the management systems in place in each area. The completeness and accuracy of catch information has improved steadily. Minor adjustments are being made in the systems to provide area breakdowns consistent with Treaty requirements. For monitoring and control of intercepting fisheries the Canadian fishing area on the approach to the Naas River has, for example, been subdivided to create a sub-area in which Alaska-bound pink salmon were found to be abundant at certain times of the fishing season. Greater attention is being given to recreational and subsistence catches. For some areas, problems exist in ensuring completeness and timeliness in the preparation and exchange of such data. Measurements of mortality among salmon discarded in fisheries targeting on other fish (e.g. "shakes") in troll fisheries or incidental catches of prohibited species or size groups in trawls are becoming increasingly important as an element in estimating total removals.

Despite the latter difficulties, progress in developing appropriate current catch statistics to meet Treaty needs has been generally satisfactory. Nevertheless, problems do exist in facilitating the effective exchange of information. Such problems include differences in the format for recording of information (particularly the designation of time periods) and lack of standardized systems for direct exchange of information between computers. The quality of catch statistics may have also been impacted by changes in commercial accounting systems, e.g. numbers of fish versus pounds. Efforts to standardize formats, develop computerized data exchange systems and to evaluate the quality of catch data (perhaps coordinated through the Statistics and Research Committee) would seem worthwhile. An outgrowth of these efforts should be the development of an information system which allows for ready access to standardized catch and effort data or data sets which can be easily equated to each other.

4.1.2 Stock identification

As pointed out in earlier sections of the report, both Parties have placed high priority on research to identify the national origins of salmon taken in the fisheries and by far the greatest part of the Treaty-oriented research programs in both countries are associated with this goal.

As outlined in Section 3, there has been substantial and rapid progress in this field in recent years resulting from marine tagging programs, coded-wire tagging of juveniles, and studies of biological markers (e.g. electrophoretic, scale and

parasite characteristics). Proposals for expanded work in this field are numerous.

Stock ID work demands a high degree of international cooperation since in most cases collection of samples must be done in both countries simultaneously. Improper planning and integration of such studies can greatly reduce their effectiveness. During interviews the consultants were informed of instances where CWT taggings were being conducted in one country of which the other country was not aware and was therefore not making provisions for recovery. Closely coordinated planning is obviously needed.

With the profusion of methodologies and needs for application, demands for stock ID work far exceed available funding. Approaches between different laboratories using the same techniques sometimes differ, tending to create misunderstandings and sometimes lack of confidence in the use of such techniques. The techniques vary in their utility and cost effectiveness depending on circumstances. Application of coded-wire tags coupled with sampling programs covering all major fishing areas to which the stocks contribute are useful for estimating the contribution of individual stocks to complexes of fisheries and for estimating exploitation rates on various stocks. On the other hand, biological marking studies, based on comparison of fish taken in individual fishing areas with sets of standards from streams of origin, are useful for partitioning aggregate catches in the fishing areas between contributing stocks. To achieve the same

result using CWT's would require tagging all stocks contributing to the fishery. The report of the Coho Technical Committee discusses such differences in the utility and applicability of various techniques.

Because of the great importance placed on stock ID work and limited research funding, the two governments and the Commission are continually faced with making selections between options available. The problem is compounded by the fact that proposals arise piecemeal on a species-by-species, area-by-area and technique-by-technique basis. Such proposals come from each of the Commission's five technical committees and participants in the Southern Panel. Stock ID work is also considered by the Research and Statistics and Data Sharing Committees as well.

In view of this situation it would seem timely for the governments and the Commission to spend some time and effort conducting an overall review of stock ID technology and of the effectiveness of present approaches, with a view to:

- Examining stock ID methods in terms of their assumptions, analytical techniques and sampling systems which drive stock composition estimates;
- Providing background to assist each government in making choices in stock ID programs;
- Identifying opportunities for cooperation between agencies in the standardization of techniques and in the development of new techniques;

- Identifying situations where there are needs for closer coordination between agencies in the planning and conduct of stock ID programs;
- Identifying areas in which stock ID information is needed on a priority basis.

With respect to the last point, the consultants note a wide disparity in available information and on investigative effort between species and stocks. For example, stock ID information for sockeye is relatively comprehensive as the result of major past efforts by IPSFC in the south and by major efforts by agencies of the two governments in the north. On the other hand, knowledge of the origins of cohos in fisheries everywhere is abysmally weak. Such differences arise particularly because some species or stocks pose more difficulties than others and partly because of past priorities established by government agencies within their own programs. The overall review proposed above should include considerations of weighting priorities taking into account the importance of the stocks in question in the context of Treaty implementation.

4.1.3 Age information

Information (usually determined by examination of scales) on the age of salmon caught is not required for short-term control of fisheries to meet Treaty obligations. It is however required to measure the productivity of the stocks (since the total contribution of each year's spawning to the fisheries requires estimating the numbers of fish returning at different ages in

subsequent years). Age data is also important to abundance forecasting techniques.

Both countries sample catches for age determinations but the consultants did not have an opportunity to assess the adequacy of the program presently underway.

4.1.4 Effort

Effort data are also not essential for short-term implementation of the Treaty. However, data on catch/effort are of value in assessing the availability of the stocks to fishing and therefore useful in interpreting the significance of fluctuations in catches and in-season abundance measures. Thus, if a fishery exceeds or fails to attain specified targets, catch per effort data can help determine whether such deviations were the result of changes in fish availability or of the effects of the magnitude of fishing effort or management measures applied.

All management agencies keep comprehensive records of the numbers of vessels fishing and of the duration of their fishing. As in the case of age composition data, however, the consultants did not have the opportunity to assess the adequacy of existing programs.

4.2 Factors Affecting Abundance

Information on factors affecting the abundance of salmon is required mainly to meet the first principal objective of the Treaty, namely, "to prevent over-fishing and provide for optimum production." Essentially, work required to provide information

in this field involves the measurement of productivity and of physical and biological attributes affecting productivity.

It is beyond the purview of the present brief report to discuss extensively the content of programs that would be required to meet Treaty commitments associated with the question of productivity. As outlined in Table 4, these would include such areas of inquiry as the production limitations in the freshwater and marine habitats, freshwater and marine environmental competition, etc.

For present purposes, to initiate discussion, a somewhat broader perspective would seem desirable. The tools available to the Parties to avoid over-exploitation and to optimize production are first, the control of fishing and/or fishing mortalities (direct and indirect) to provide desired levels and quality of spawning escapements (taking into account the timing of spawning runs and their distribution on the spawning grounds) and second, altering the freshwater environmental conditions to increase survival (enhancement). Establishing appropriate escapement levels first and foremost requires information on the relationship between the abundance of the spawning stocks and the magnitude of resultant returns-stock/recruitment relationships. Information on the relationship between density of spawners or of young fish and the capacity of the habitat to support them can provide supplementary information to explain or qualify findings resulting from gross measurements of spawners and returns.

With respect to enhancement, information is required to support technological development and also to assess the consequences of environmental manipulation with relation to where and when and in what quantities fish will be produced and the impact that such additions have on existing runs. Such information is of vital importance in arraying options for future cooperative efforts to increase production through artificial means. Specific discussion of enhancement activities is included in Section 4.4 below.

At present management of fisheries in both countries involves the establishment of escapement targets and the structuring of fisheries to provide exploitation patterns that will permit achievement of such targets. The setting of escapement goals has often been a pragmatic exercise rarely based on firm information of spawner/recruit relationships or on other measures related to potential productivity. Rules of thumb such as average densities of spawners per unit area of available spawning ground, or achievement of escapement levels that were estimated to have occurred at some time in the past when production was high, are often used. To the consultants' knowledge, however, with a few exceptions, there is little work being done that is directly aimed at gaining more precise knowledge of productivity and of the related subject of the effects of escapement levels on production.

The foregoing appraisal is not meant as a criticism of work currently underway. It is understandable that urgent short-term

needs to define migration patterns of salmon, to identify their origins, and to measure run contributions to fisheries in order to assemble and implement agreed upon seasonal fishing plans has taxed the technical resources of both sides. Also, as indicated in Table 4, much of the information (e.g. contributions of individual stocks to fisheries) required to meet short-term goals is also needed for longer term studies. It is also understandable that administrators establish escapement targets on the best information available and that such targets are therefore often "guesstimates." As outlined in the report of the Chinook Technical Committee, however, such targets must be viewed as interim objectives.

Indeed, there is little certainty that escapement targets currently selected may be those that will result in "optimum production." Considerations leading to this view include:

- For many stocks (e.g. those of the Fraser), historic levels of production were much higher than they are now and were undoubtedly achieved with lower levels of exploitation; had modern-day rates of exploitation been applied, catches would have been even higher. Thus, the potential levels of catch could be substantially higher than now realized and, in all probability, such higher levels were provided in the past by permitting escapements substantially higher than those existing today.

- Current management practices, which often aim to provide constant escapements, limit the variability of escapement levels. Thus, observable spawner/return relationships are restricted to a

relatively narrow range of spawner abundance and therefore tend to be of limited value in assessing the consequences of providing substantially larger or smaller escapements.

- Because of technical difficulties, estimates of the abundance of spawners are incomplete and inaccurate.

Whereas it is recognized that greater effort on more short-term problems has been necessary during the Treaty's start-up period, continued concentration on such programs will not yield the span of information required to bring about substantial increases in long-term production. Hence, meeting the short-term technical needs would leave the Commission with "half-a-loaf." It is clear that the Treaty text and the fishing industries and other users on both sides who endorsed the Treaty formulation, anticipated that the new international agreement would lead to increased fish production. Thus the longer term information needs become an essential ingredient in meeting the principles endorsed by the two Parties. In this regard, the consultants strongly feel that the two governments should devote greater efforts to the study of productivity.

In consultations with participants, the point was made that under the Treaty, the state of origin has the responsibility of setting the management objectives for fisheries on stocks originating in its waters, including the establishment of escapement goals. Consequently, if one takes this view, supporting studies of productivity are a national responsibility falling within the purview of the Commission only in a limited

way. The role of the Commission in the conduct of productivity studies would thus be similarly limited.

Nevertheless, in the consultants' view, one of the major benefits of the new Treaty would seem to make available the technical capabilities of the two countries to enrich their aggregate competence in order to meet common problems. It would therefore seem desirable to facilitate cooperation between the two sides in planning and conducting fundamental studies, thus permitting both to better define the productive potential of their resources and to ultimately increase production.

To this end it would seem appropriate for the Commission to give consideration to research on productivity and to seek opportunities for technical cooperation in this field between agencies in the two countries. It might be useful in the near future for the Commission to convene a meeting of technical specialists to examine the existing state of knowledge on factors affecting the abundance of salmon and on research required to gain a better understanding of the production process.

Two items would seem of particular relevance to the Parties. The first is the question of escapement estimations. Inadequacy in key measures of spawner abundance was repeatedly identified as a problem by investigators with whom the consultants met. Methods varied greatly between agencies. The establishment of representative index stream systems (in order to avoid the need for covering large numbers of rivers) is under development for several species and areas. It would seem worthwhile for scien-

tists of the two countries to consolidate their efforts to develop comparable and improved techniques for spawning escapement enumerations and to thoroughly evaluate the utility of index system approaches.

The second subject for which cooperative study would seem desirable is the assembly of historic catch statistics. As outlined above, for many stocks, consistently high levels of production prevailed in earlier years. Study of such statistics could provide valuable insights into the productive potential of the stocks. Old catch statistics are sometimes incomplete or erroneous and difficult to relate to catches in modern fishing areas. Nevertheless, in Alaska and British Columbia, attempts have recently been made to collate and reinterpret pre-1950's catch information. Combined with modern information on assumed origins of fish in different fishing areas, the information would be used to develop long-term series of data on production of important stocks or complexes of stocks. It may be of value for scientists in the two countries to consider cooperative analyses and exchanges of old statistical data to determine their utility for studying productivity of relevant stocks over the long term.

The foregoing concentrates on the study of stock abundance and on spawner/recruitment relationships. Studies of effects of environmental factors on productivity are also of obvious importance. Consideration of possible limitations on the productive capacity of the marine environment and of interspecific competition at sea could be an especially important

factor in determining target levels of production from freshwater.

Finally, it is noted that present fishing plans established under the Treaty are quite naturally based on the status quo with respect to fishing patterns and stock mixtures in the fisheries. Optimization of production in the future may involve major changes in stock levels and stock mixtures within existing fishing areas. For the purposes of long-term planning, the Parties should begin to consider the implications of potential changes in production, including those brought about through enhancement. Such considerations might include assessments of the productive potential of the resources under maximum production conditions and the implications of production at such levels on stock mixtures and abundance patterns in fisheries. Such studies would seem necessary for the two governments ultimately to come to grips with the question of determining target levels for optimum production and for developing harvesting strategies that will maximize the benefits to each.

Important tools for the study of population dynamics and behavior of stocks are models, based on knowledge of the migratory movements of the stocks and on fishing power of the fleets. Models of this character permit scientists to predict the consequences of variations in the strength and contributions of the stocks to exploitation patterns and escapements. A number of such models exist and are being used in the Commission's work (e.g. the Washington State Department of Fisheries/National

Bureau of Standards Model) but because different models are used for different species and areas and differ in methodology and objectives, their general utility for the specific work of the Commission is limited. The Coho Technical Committee has pointed out the need for further work to develop appropriate models, emphasizing ease of construction from raw data, ready inter-relationship between models used for different species and simplicity of operation. The Committee urges that such model development work should be a "... joint effort to assure mutual confidence in application." The consultants strongly support this initiative and believe that the Research and Statistics Committee (providing cross-species, cross-area linkages) should coordinate the development of improved models of general utility for the Commission's work. It should be noted that such models have applicability beyond studies of productivity in that they are important tools for the construction of fishing scenarios required for the development of both long and short-term fishing plans.

4.3 Factors Affecting Availability

Environmental and biological factors (other than population dynamics) affect the extent to which salmon are vulnerable to fishing in particular fishing areas. Seasonal and annual variations in feeding behavior and swimming depth can affect the extent to which salmon are available to troll gear. Of particular relevance to the implementation of the Treaty are variations in migration patterns. A good example is the variable propor-

tions of Fraser-bound salmon that migrate through the northern Johnstone Straits (where all fisheries are Canadian) and southern Juan de Fuca Strait (where both Canadian and United States fisheries operate) approaches to the river. The proportions of sockeye runs passing through Johnstone Straits can vary between 10 and 80 percent. The two countries conduct their fisheries on Fraser-bound sockeye and pinks to meet escapement targets and to provide an agreed division of the catch between the two countries. Development of fishing plans within the Commission requires forecasting the proportions of the stock entering via the two approaches. During the season, fishing times are varied if the runs deviate from their expected patterns. Administrative problems in the field are severe if deviations are substantial. Changing migration patterns obviously impact management strategies for many stocks other than the Fraser.

Staff at IPSFC have developed forecasting techniques relating the proportional "diversion" through Johnstone Straits with oceanographic events. Whereas the approach is subject to error, the techniques remain of substantial value in the planning and control of the fisheries on Fraser-bound salmon.

Nevertheless, participants in the Southern Panel expressed the view that uncertainties in the migration routes of Fraser salmon remained an exasperating difficulty with respect to in-season management and that work to improve the accuracy of forecasting would be invaluable.

Availability problems raise the question of the need to know more about the effects of the marine environment on salmon. It was noted in the previous section that information on the carrying capacity of the marine habitat could be of considerable importance in the future. This no doubt is a reflection of the assignment of priorities by research agencies in the two countries; work at sea requiring large vessels is very expensive.

4.4 Enhancement

Except for transboundary rivers, where the Treaty mandates close cooperation, research and conduct of enhancement programs are national prerogatives as long as the results of the activities are not inconsistent with the principles of the Treaty (as enunciated in Article III). Nevertheless, because the output of enhancement facilities can have major impacts on the stock mixes in fisheries and because enhanced stocks can usually withstand higher rates of exploitation that natural ones, enhancement activities have serious implications for management. For this reason, in negotiating the Treaty, the Parties took special care to ensure that there would be close consultation between governments, particularly regarding the initiation of new enhancement projects. It was anticipated that both sides might blend enhancement projects in their domestic management programs in order to improve the basis for managing fisheries on natural runs. For stocks fished by both countries or in fisheries where such enhanced fish might be harvested along with fish bound for

the other country, close consultation between the Parties would obviously be most desirable.

Effective consultation, and where appropriate, cooperative planning (especially for the transboundary rivers where cooperation is specifically required), will require considerable technical input, particularly with respect to identifying opportunities, designing programs to ensure the effective development of selected projects, assessing the likely production from proposed facilities and its distribution among fisheries, and monitoring actual production when it comes on line.

It is noted that, within the Commission, the Parties have not yet been able to devote much attention to enhancement questions. It would seem important to do so in the near future. It is also noted that fishing regimes are already being affected by the changes in enhancement production (e.g. adjustments for "add-ons" in Alaska). As outlined in Section 4.2 above, enhancement production and the possible impact of such production on the fisheries would seem necessary as background for the development of programs (within each country and developed through the Commission) aimed at attaining the Treaty objective of optimizing production.

As with studies of productivity, it would seem desirable to use the umbrella of the Commission to foster cooperative work between specialists in the two countries to improve existing enhancement technologies and to develop new ones.

With respect to current enhancement activity, there is an urgent need to initiate and set in place a system for careful performance evaluation, including the development of an appropriate information system to assess future enhancement strategies. Work to determine the reasons for success or failure of existing facilities and to improve the productivity of artificial propagation facilities, e.g. disease control, diet, genetic management and determination of optimum conditions for release should be expanded.

4.5 Conclusion

The foregoing has been a very general appraisal of the types of information the consultants view as being required for implementation of the Treaty. Consistent with their Statement of Work and oral instructions, they have not reviewed individual research programs in progress or planned. Despite the generality of the presentation, it is hoped that the outline will provide a rough framework for more in-depth discussion within the Commission. Further consideration of the question of appraising the utility of research programs is contained in the next section of the report dealing with institutional arrangements.

5. INSTITUTIONAL ARRANGEMENTS

As part of their enquiry, the consultants were required to address questions of cooperative research and data sharing. At the core of any cooperative efforts are the mechanisms within the Commission for facilitation of consultation and joint action. Most of the officials interviewed had concerns about existing arrangements and expressed views regarding their improvement. For these reasons the consultants offer their views regarding institutional arrangements within the Commission for cooperation in the field of research.

Although most scientists and administrators interviewed expressed enthusiasm regarding the Commission's operations during its first year, many expressed frustration with difficulties being encountered in meeting Commission deadlines and in developing efficient procedures for the exchange and analysis of information. Virtually all participants were concerned about the immense amount of time required for report preparation and for international meetings.

Despite these concerns, recalling the complexity and political sensitivity of the technical issues associated with the negotiation of the Treaty, the consultants feel that progress to date in the Treaty's implementation has been remarkable. This is particularly true when one recalls that the Treaty, establishing firm legal commitments for technical cooperation, data exchange, etc., has been in place only since March 1985 and that the Commission's by-laws, specifying procedures for panels and

committee activities, have been in place for less than a year. In this regard, the consultants feel that most of the difficulties that have been encountered can be characterized as "start-up" problems. It is apparent that many of these problems are being worked out satisfactorily. The consultants therefore do not feel it is necessary to comment further on the short-term mechanical aspects of the Commission's operations.

The difficulties being encountered, however, emphasize that the Treaty places major new demands on the technical capabilities of both countries. These increased expenditures of technical resources are necessary if the substantial benefits that will flow to each side through implementation of the Treaty are to be realized. When the Treaty was negotiated it was clear that an increase in the volume of data compilation, analysis and exchange in both countries would be required. It was also to be expected that Treaty commitments would have an important influence on the selection of research projects to be funded on both sides. The Treaty principle concerned with each Party receiving benefits equivalent to the production of salmon originating in its own waters adds a new dimension to research activity beyond that which was conducted in each country to meet purely domestic management and development objectives. Requirements to limit interceptions through development of obligatory fishing regimes and in-season fishing control also add new requirements for precision and timeliness going beyond purely national demands. Finally the commitments to exchange and cooperatively analyze and

evaluate information on an international level add still another requirement beyond domestic processes. The consultants feel that it would be most desirable for the Parties to begin the process of setting long-term targets for cooperative fisheries development within the Treaty in order to provide firmer direction to technical programs being conducted within the Treaty framework and to provide a quantitative basis for measuring the benefits expected to flow from implementation of the Treaty.

Despite the Commission's promising start, there do appear to be some problems developing that go beyond the "start-up" category. These include:

- Mismatches in the timing of data availability and of meetings;
- Complexity and lack of consistency in the preparation of data and of reports considered by the Commission;
- Lack of structure within the Commission for orderly appraisal of the utility of existing and planned research programs and for cooperative planning.

5.1 Scheduling of Data Exchanges and of Meetings

The present cycle of information provision for the Commission requires presentation of material summarizing the results of the previous season's activities in the Fall and the presentation of material for planning the next season's activities in February. Many technical specialists consider the timing to be too precipitate. In the autumn some late-season fisheries are still in progress, or barely completed and the spawning runs of

many stocks are not yet completed. The assembly of post-season information in the Fall is therefore incomplete or hurriedly prepared. The timing of preparatory information in the Spring tends to conflict with domestic timetables for preparation and array of similar data, resulting, in some cases in wasteful repetitive reworking of the same information. It is the strong feeling of many technical specialists that attempts should be made to tailor the timing of meetings to fit better with natural fishing and consequent analytical cycles; such rescheduling would save a great deal of time and effort and would provide the Commission and the Parties with more complete and dependable information.

On the other hand, the Commissioners and administrators charged with the responsibility of implementing the Treaty are faced with a different set of problems. The timing of their requirements for information is constrained by the need to review both post and pre-season information with representatives of user groups as part of domestic consultative processes. Such consultations are affected by the availability of personnel which, in turn is dependent on the timing of fishing seasons.

In the end the timing of information exchange and of meetings must represent a compromise. Whether the present cycle represents the best compromise is difficult to tell; it has developed against the background of intensive activity on both sides to put the treaty organization in place. As such, enough consideration may not have been given to the subject. The

Commission should give specific attention to the question of scheduling of meetings, perhaps through the establishment of an ad hoc group including some Commissioners, panel members and technical specialists to make recommendations aimed at improving the timing of information exchanges, and of meetings of technical committees, panels and the Commission. Evaluations leading to such recommendations should weigh most carefully the trade-offs between precision and completeness of data on the one hand and administrative efficiency on the other.

5.2 Inconsistencies in Data Exchange and Reporting

Not unexpectedly, the formats for exchange and analysis of data and for reports of Committees and working groups to the panels and to the Commission have not yet been finalized. To an outsider, differences in the structure of individual committee reports and in the subjects they address make it very difficult to develop a comprehensive picture of the technical issues faced by the Commission and of the approaches that are being taken to deal with them. It would seem to the consultants that Panel members and Commissioners might also experience the same type of difficulty in absorbing the welter of technical material presented in so many different forms. At the technical level it is understood that inconsistencies in the format and timing of material submitted to the Commission by the two Parties are a continuing source of misunderstanding and confusion, impeding the work of some of the technical committees. In some subject areas (e.g. coded wire tagging data), attempts are being made within

the Commission to provide for standard formatting. In other cases (e.g. catches, statistics, see Section 4.1.1) efficient systems for machine communication of data in a standard way still have to be achieved.

Considering these problems, there would seem to be considerable merit to the Commission giving special attention to means of standardizing and simplifying procedures for providing data to the Commission and for reporting by technical committees to the appropriate panels and to the Commission as a whole. This task should involve the standardization of terminology which differs between committees and national sections.

5.3 Lack of Effective Procedures for Appraisal and Planning of Research

At present, cooperative international evaluation and interpretation of the results of research and determination of research needs is carried out mainly within the Commission's five technical committees, each of which makes recommendations regarding future needs. The Research and Statistics Committee and its subsidiary bodies may also make recommendations regarding research. The results of the Committees' deliberations are considered by appropriate panels which, presumably could make recommendations themselves regarding research. In the end, all recommendations would presumably come to the full Commission for consideration. As yet the Commission does not seem to have acted on any recommendations regarding research. Presumably therefore

such recommendations merely remain on the record for agencies in both countries to review and consider without commitment.

The consultants pursued the question of research evaluation and planning with most participants and received a wide variety of opinions. At one extreme, some though that it was not appropriate for the Commission to evaluate research being conducted; such evaluation was viewed to be a national preserve. Those holding this view saw only a very limited role for the Commission in coordinating research planning. At the other end of the scale, some saw considerable merit in the Commission playing a very active role in evaluating current research and in making recommendations regarding future research. A number of people thought that the Commission might go so far as to develop some system for prioritization of research. Indeed, in the report of its May 21-22, 1986 meeting, the Research and Statistics Committee itself has recommended that it "... develop standardized evaluation format for reviewing ongoing programs for relevance to Canada/U.S. Treaty issues."

Regardless of which position people took, it is evident that there is no structure within the Commission for comprehensive review and evaluation of research. The consultants strongly believe that such a mechanism should be brought into being. It is their view that whereas the planning and conduct of research remains clearly a national prerogative, the Treaty clearly requires the Commission to review research being undertaken under terms of the convention and to take an active role in coordi-

nating such research. The Commissioners themselves could play an important role in establishing better cooperation between scientific agencies in the two countries, in identifying questions that needed to be answered to facilitate implementation of the Treaty and for settling technical disputes (short of invoking the Treaty's technical dispute settlement procedures) regarding such questions as selection of methodologies.

The extent to which the Commission delves into research questions and the nature of its recommendations to governments on research questions is, of course, up to the Commissioners themselves. However, the consultants believe that improved mechanisms should be put in place in order to facilitate any such considerations. The present fragmented treatment of research issues within the Treaty organization pose a formidable barrier to ready handling of research questions by the Commission.

PSC's committee structure is quite different from any other fisheries commission in which Canada and the United States have been parties. Normally a committee equivalent to PSC's Standing Committee on Research and Statistics has been exclusively responsible for answering the Commission's (and subsidiary panel's or other subsidiary unit's) technical enquiries. In PSC this responsibility is divided among five technical committees plus the Research and Statistics Committee and its subsidiary working groups. The consultants do not view this difference as necessarily being a flaw, since the close reporting relationship between technical committees and panels seems to be providing the

Commission with a very efficient avenue for the direct application of technical information to the Commission's practical problems. In this regard, it would seem quite appropriate for the results of research and first identification of research needs to arise within the technical committees.

It is after these first analyses and first proposals for future work are made that difficulties would seem to arise. Reports of individual technical committees reveal uncertainties regarding the efficacy of certain methodologies and often make recommendations for work to improve the basis for the groups deliberations. Often several committees will consider the same methodological approaches from the particulary point of view of the species or area with which they are dealing. Recommendations are made freely without consideration of competing demands for funds, etc. The net results is that the Commission is presented with a patchwork picture of research results and future needs. If the Commission were faced with making judgments on the relative effectiveness of work being considered by individual committees or of establishing priorities among competing proposals for future work being put forward by the different groups, it is hard to see how it could do so without some mechanism for making objective technical assessments. Governments considering the fragmented appraisals and proposals must be faced with the same problems.

Under such circumstances, it would seem desirable to seek means of providing a more comprehensive appraisal of the results

of research conducted by the Parties under terms of the Treaty and on identification of future research needs. In this regard, the existing Research and Statistics Committee would seem to be the logical focus for preparation (for consideration by the Commission) of an appraisal of current research activities and a listing (with evaluations of their utility) of future requirements. The Committee itself has proposed that it perform such a task. However, considering the effectiveness of the present technical committee structure, it would seem most appropriate for many of the appraisals and proposals for future work to arise from such committees and also for representatives of the technical committees to participate with the Research and Statistics Committee in preparing reviews of current research results and in assessments of future needs. It should be emphasized that the Research and Statistics Committee would not normally be expected to make its own selections of future research projects for consideration by the Commission and by governments; it would instead be expected to provide assessments of the utility and cost-effectiveness of approaches proposed from various quarters. On receipt of such appraisals, it would be up to the Commissioners to make or not make such recommendations as they see fit.

The foregoing discussion focuses attention on the question of evaluating of research. The Research and Statistics Committee is proposing to develop a standardized evaluation format and technical staff of the Northwest Indian Fisheries Commission and have prepared an interesting paper suggesting procedures for

prioritizing research proposals. Such attempts to develop objective systems for evaluating proposals have merit. It is the consultants' view, however, that with very different administrative systems in the two countries and different domestic priorities, it will be very difficult to develop a system that is generally acceptable. Nevertheless there is a clear need to outline research proposals in a comparable manner indicating how they will contribute to solving the problems before the Commission and their costs. The consultants therefore support attempts to develop procedures for making such evaluations as background for consideration of research proposals by both parties independently and, if desired, by the Commission.

5.4 Publications

On undertaking their assignment, the consultants found it difficult to find a comprehensive account of the technical issues facing the Commission. Although the reports of all the technical committees are carefully prepared and reflect the high level of technical competence of the specialists involved in their preparation, the reports themselves require a great deal of "insider" knowledge to understand. The consultants note that the Commission Secretariat has begun to consider the preparation of the Commission's first annual report and that a documentation system has been developed.

Whereas considerable attention is being paid to the question of publication, it is not clear to the consultants the extent to which forthcoming reports of the Commission will clearly outline

the technical issues facing the Commission and how these issues are being dealt with, including the presentation of the results of research bearing on the questions. The consultants believe that considerable attention should be given to this question since it is through the public records of the Commission activities that its performance will be measured on an historic basis. A review of the published records of other Canada/United States and multilateral Commissions in which both countries have participated would be instructive.

Table 1. Specific requirements of the Treaty with respect to control of fisheries and enhancement and conduct of studies as specified Annex 4

	TRANSBOUNDARY	NORTHERN BOUNDARY
FISHING PLANS	On Stikine & Taku, on a species by species basis, limitation of 1985 & 1986 Canadian in-river fisheries to percentages of allowable catches, or to numbers of fish or to incidental capture only.	Numerical limitations on catches in certain U.S. sockeye net fisheries and on certain Canadian pink net and troll fisheries during 1985 and 1986. Regimes post-1986 to take into account results of 1984/85 tagging programs. In 1985 both sides to reduce interceptions of Portland Canal chums.
MANAGEMENT STRATEGIES	Regulation of fisheries of both countries to meet annual agreed escapement targets (with specific numerical rebuilding objectives for chinook) and Canadian entitlements. In-season run determination and management action required for 1985 Stikine sockeye fishery. Unspecified restrictions to conserve depressed Alsek sockeye and chinook stocks. Improve procedures for cooperative management.	Parties to implement management measures taking into account run sizes and to permit Parties to harvest own stocks.
ADJUSTMENTS	Compensatory adjustments if entitlements not achieved due to actions of other country.	
ENHANCEMENT	Identify enhancement opportunities; undertake feasibility studies for new enhancement projects.	Undertake assessments to identify possible measures to enhance Portland Canal chum stocks.
STUDIES	Assemble and refine data on migrations, exploitation and spawning requirements. Examine past management regimes and recommend improvements	Undertake assessments to identify possible measures to restore Portland Canal chum stocks. Evaluate effectiveness of management actions. Identify and review status of stocks. Array data on harvest rates and develop a joint data base. Collate productivity information as basis for determining escapement levels and harvest rates to maximize production. Present historical fisheries data. Devise analytical methods as background for development of management strategies. Identify information and research requirements. Make annual assessments and recommend conservation measures.

Table 2. Specific requirements of the Treaty with respect to control of fisheries and enhancement and conduct of studies as specified Annex 4.

	CHINOOK	COHO
FISHING PLANS	In 1985 & 1986, numerical limits applied to all gear chinook catch in Southeast Alaska & northern B.C. and in certain southern B.C. troll and sport fisheries. General obligation to follow strategies outlined immediately below.	In 1985 & 1986, numerical limits applied to Canadian West Coast Vancouver Island troll fishery In 1986 and thereafter implement conservation measures taking into account Canadian contributions and sharing consistent with Article III. In 1987, Commission to set specific harvest levels for above-mentioned intercepting fisheries
MANAGEMENT STRATEGIES	Limit fisheries to halt decline in depressed stocks; by 1998 restore production of natural chinook stocks through reduction in current exploitation rates. All fishing mortality to be considered in implementing rebuilding program. Manage all fisheries so that savings from above limitations accrue to spawning populations. After rebuilding, develop regimes to maintain stocks at optimum productivity.	Except where specific regimes apply, Parties endeavour to limit incidental intercepted coho catches. For southern B.C./Washington area, Parties will establish fishing regimes for coho consistent with the Treaty. For 1985, Parties to maintain existing management objectives for the latter area.
ADJUSTMENTS	In 1986 and thereafter, reduce ceilings if chinook abundance drops. If overruns, Party will adjust in future to ensure planned long-term rebuilding. Ceilings may be raised if enhancement additions can be demonstrated.	Significant deviations from numerical limits compensated for in later years if consistent with conservation requirements.
ENHANCEMENT	Recommend strategies for use of enhanced stocks. Ceiling adjustment for anhancement as indicated above.	
STUDIES	Evaluate all sources of induced fishing mortality. Evaluate consistency and effectiveness of management measures. Annually assess stocks and recommend changes to the management regimes. Develop procedures to evaluate rebuilding progress. Recommend research for implementation of the rebuilding program.	Evaluate effectiveness of management actions. Identify and review status of stocks. Array data on harvest rates and develop a joint data base. Collate productivity information as basis for determining escapement levels and harvest rates to maximize production. Present historical fisheries data. Devise analytical methods as background for development of management strategies. Identify information and research requirements. Make annual assessments and recommend conservation measures.

Table 3. Specific requirements of the Treaty with respect to control of fisheries and enhancement and conduct of studies as specified in Annex 4.

	FRASER SOCKEYE & PINKS	SOUTHERN B.C.-WASHINGTON CHUMS
FISHING PLANS	For 1985 through 1988 and 1989 through 1992, numerical entitlements for U.S. fisheries in Fraser Convention Area.	
MANAGEMENT STRATEGIES	Measure to take into account management of other stocks in the area.	Develop fishery regimes for 1985 and thereafter.
ADJUSTMENTS	Proportional adjustments of U.S. entitlements to account for deviations in expected returns. No sooner than 1989, consider adjusting regime vis a vis Article III. Compensatory adjustments in later years if regulatory measures fail to provide entitlements. Convention Area may be adjusted to simplify domestic management.	
ENHANCEMENT	No upward adjustments in U.S. entitlement if TAC increases as result of Canadian enhancement.	
STUDIES	Division of responsibility for data collection, analysis and reporting between Parties and Commission staff (as per exchange of letters between Governments).	Identify and review status of stocks. Array data on harvest rates and develop a joint data base. Collate productivity information as basis for determining escapement levels and harvest rates to maximize production. Present historical fisheries data. Devise analytical methods as background for exploration of management strategies. Identify information and research requirements. Make annual assessments and recommend conservation measures.

Table 1. Listing of information required to meet the four principal purposes of the Canada/United States Treaty on Pacific Salmon.

INFORMATION ITEM	I PRE-SEASON PLANNING	II IN-SEASON CONTROL	III POST-SEASON MONITORING	IV PRODUCTIVITY
A. HARVESTING				
1. Numbers and weights of fish caught by time, area and species	X	X	X	X
2. River of origin of fish caught	X	X	X	X
3. Age of fish caught.				X
4. Fishing effort expended	X	X	X	X
B. FACTORS AFFECTING RESOURCE ABUNDANCE				
1. Escapement abundance, timing and distribution	X		X	X
2. Capacity of fresh-water environment				X
3. Capacity of marine environment				X
4. Sources of environmental variability	X	X	X	X
5. Inter- and intra-specific effects				X
C. FACTORS AFFECTING AVAILABILITY				
1. Variations in distribution and migratory patterns	X	X		
2. Environmental and behavioural effects on fishing	X	X		
D. ENHANCEMENT				
1. Enhancement technology	X			X
2. Enhancement methodology	X			X
3. Enhancement practise	X			X

APPENDIX 1

OFFICIALS CONSULTED

APPENDIX 1

OFFICIALS CONSULTED
(WITH AFFILIATION AND PSC COMMITTEE ASSIGNMENTS)

Seattle, July 11

Tom Jensen, CRITFC

Wayne Shinners, DFO; Canadian Commissioner

Ian Todd, PSC; Executive Secretary

Don Bevan, UW; R&S, Data Sharing, Southern Panel, Chinook

Olympia, July 30

Northwest Indian Fisheries Commission

Mike Grayum; Coho

Gary Graves; Chum

Larry Rutter

Washington Department of Fish and Game

Gene DiDonato; Southern Panel

Dennis Austin

Tom Cooney; Chinook, Coho

Rich Lincoln

Don Haring; Chum

*Bill Wilkerson, U.S. Commissioner contacted via phone August 28.

Portland, July 31

Burnie Bohn, ODFW; Southern Panel

Howard Schaller, CRITFC; Chinook

Phil Roger, CRITFC; Data Sharing

Tom Jensen, CRITFC

Jack Donaldson, ODFW; U.S. Commissioner, R&S

Kirk Beiningen, ODFW

S. Timothy Wapato, CRITFC; U.S. Commissioner, F&A

Seattle, August 1

Rollie Schmitten, NMFS; Fraser and Southern Panels

Dick Thompson, NMFS

Gary Morishima, Quinault Nations; Data Sharing, Chinook, Coho

Ken Henry, NMFS; Data Sharing, Chinook, Coho, Chum

Vancouver and New Westminster, August 12

Wayne Skinners, DFO; Canadian Commissioner

Garrett Jones, DFO; Canadian Alternate Commissioner, Fraser, F&A

Ralph Shaw, Alternate Canadian Commissioner, R&S

Jack Nichol, Alternate Canadian Commissioner

Fred Fraser, DFO; Fraser Panel

Ian Todd, PSC; Executive Secretary

Nanaimo, August 13

Brian Riddell, DFO; R&S, Data Sharing, Chinook

Ron Kadowaki, DFO; Coho

Don Anderson, DFO; Chum

Juneau, August 21

Laird A. Jones, ADF&G

Jim Olsen, NMFS; Northern Boundary, Transboundary

David Cantillon, ADF&G; Northern Panel, Northern Boundary

Scott Marshall, ADF&G; R&S, Data Sharing, Transboundary, Chinook

Mel Seibel, ADF&G; Chinook, Coho

Steve Pennoyer, ADF&G; Northern Panel

Prince Rupert, August 22

Daddy Greene; Canadian Commissioner, R&S

Paul Sprout, DFO; Northern Panel

Dave Peacock, DFO; Northern Boundary

Gus Jaltima; DFO

Abbreviations

ADF&G - Alaska Department of Fish and Game

Chinook - Joint Technical Committee on Chinook

Chum - Joint Technical Committee on Chum

Coho - Joint Technical Committee on Coho

CRITFC - Columbia River Inter-Tribal Fisheries Commission

Data Sharing - Technical Committee on Data Sharing

DFO - Canadian Department of Fisheries and Oceans

F&A PSC Finance and Administration Committee

Northern Boundary - Northern Boundary Technical Committee

NWIFC - Northwest Indian Fisheries Commission

ODFW - Oregon Department of Fish and Wildlife

PSC - Pacific Salmon Commission

R&S PSC Research and Statistics Committee

Transboundary - Transboundary Technical Committee

UW - University of Washington

WDF - Washington Department of Fisheries

APPENDIX 2

HISTORICAL PERSPECTIVE

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HISTORICAL PERSPECTIVE

The complex migratory habits of Pacific salmon permit Canadian and United States fishermen to harvest substantial quantities of salmon bound for rivers of the other country. Almost from the beginning of commercial fishing for salmon in both countries such interceptions led to competition and controversy. The first such controversy arose when, towards the end of the last century, intensive fisheries for sockeye salmon bound for the Fraser River developed in the estuary and in the river itself (Canadian waters) and in the outer reaches of Puget Sound on the United States side. The four-year periodicity of Fraser sockeye runs (with greatest abundance in the 1897-1901-1905 cycle led to rounds of vitriolic exchanges across the border wherein each side blamed the other for wanton over-harvest of the resource during years of scarcity.

Between 1902 and 1906, authorities representing the Governments of Canada and of the State of Washington held a number of consultations aimed at imposing parallel restrictions on the fisheries of the two sides. These efforts met with little success. A formal intergovernmental attempt to bring order to the competitive fisheries took place in 1908 when Great Britain and the United States concluded a convention for the protection and preservation of the food fishes in international boundary waters of the United States and Canada (the so-called Bryce-Root Treaty). Under the terms of this convention, the Canadian and

United States Commissioners agreed to recommend to governments a number of regulations, including the establishment of close seasons for salmon fishing, the establishment of weekly close times (6:00 a.m. Saturday through 6:00 a.m. Monday), and limitations on methods of construction and placement of trap and seine nets. Unfortunately, political opposition prevented adoption of the regulations and the conflict continued to simmer. An astute observer of the times, John N. Cobb of the United States Bureau of Commercial Fisheries noted that whereas both sides were "...virtually interested in the preservation of these fish, they seem unable to agree upon any definite policy with regard to their conservation, although it would appear to the unprejudiced observer that it ought to be possible to find some common ground upon which they could agree."

The situation deteriorated further during World War I when, in 1917, it became apparent that a disastrous rock slide at Hells Gate in the Fraser River in 1913 had virtually obliterated the huge up-river runs of sockeye in the dominant 1897-1901-1905 cycle. In 1917, the year of return of the 1913 run, neither side applied meaningful restraints to their fisheries. By 1919 it had become apparent that the stocks in all cycles were mmission (the so-called American-Canadian Fisheries Conference). Stemming from the work of the Conference, in September 1919, the two countries signed a convention for the "protection, preservation and propagation" of sockeye salmon bound for the Fraser River. The convention was to establish an international commission with a

and British Columbia is a most surprising thing, and indicates either a most remarkable ignorance of the condition, which should have been patent to everybody, or a criminal apathy."

Mr. Cobb's criticisms were perhaps a bit strong. In any event, in the face of the deteriorating resource situation, the two governments renewed their efforts, beginning in 1917, to come to grips with their problems through the formation of a new joint commission (the so-called American-Canadian Fisheries Conference). Stemming from the work of the Conference, in September 1919, the two countries signed a convention for the "protection, preservation and propagation" of sockeye salmon bound for the Fraser River. The convention was to establish an international commission with a mandate to "... conduct investigations into the life history of the [sockeye] salmon, hatchery methods, spawning-ground conditions, and other related matters." The convention also included regulations requiring national licensing of fishing vessels, limits on the number of licenses that could be issued, time and area closures and limitations on the size and construction of fishing gear.

The convention was not ratified and for the next 20 years negotiations continued on a sporadic basis. In the early 1920's serious consideration was being given to the establishment of a five-year moratorium on the fisheries for Fraser-bound sockeye. Eventually, in 1930, the Fraser River sockeye treaty was signed and, after many delays, was ratified in 1937. Even then, under a memorandum of understanding between the two governments, the

Commission formed under the treaty was not permitted to promulgate regulations for the Canadian and United States sockeye fisheries until 1946. Formation of the Fraser Salmon Commission (albeit after an inordinate delay following first identification of the need to take action) represented the first major step taken by the two countries to reduce conflict and to provide the basis for improving the management of their competing fisheries. The Commission, with the responsibility for recommending regulations for conservation and 50:50 sharing within the Fraser Convention Area also had a clear mandate to carry out research, being required to " ... make a thorough investigation into the natural history of the Fraser River sockeye salmon, into hatchery methods, spawning ground conditions and other related matters." The convention gave the Commission power to "... improve spawning grounds, construct, and maintain hatcheries ...", etc.

The Commission's neutral staff conducted studies and devised regulatory schemes necessary to meet the terms of the treaty. Their work was highly regarded in both countries. They worked independently, however, and there was relatively little exchange of ideas and information between Commission scientists and scientists in United States and Canadian laboratories. The Commission's mandate was limited to sockeye.

During the 1950's, a number of other international issues arose creating international problems for the two countries. It soon became apparent that measures going beyond the terms of the

Fraser sockeye convention would be necessary. It is not within the scope of the present short report to describe these issues in detail. In brief, however, key events included:

- Deterioration in chinook and coho production (particularly in the Northwest States) during the late 1940's and 1950's) providing a major stimulus to the formation of the Pacific Marine Fisheries Commission (PMFC) in 1947. Through the latter Commission efforts were made to coordinate regulations of competing troll fisheries; through informal channels Canadian participation in the Commission's work was encouraged;

- Development of the abstention principle in the north Pacific;

- The threatened seaward spread of net fishing by both countries at the mouth of Juan de Fuca Strait which led, in February 1957, to the convening of a conference on Coordination of Fisheries Regulations and the development of a "gentleman's agreement" to prohibit offshore net fishing. At the same meeting Canada adopted troll regulations consistent with those in force in Washington and Oregon;

- Increased national fishing efforts on the high seas.

Toward the end of the 1950's and throughout the 1960's, Canada/United States Pacific salmon problems continued to multiply and to contribute to an increasingly acrimonious international fisheries atmosphere. During this period, significant events included:

- Stemming from Law of the Sea conferences in 1958 and 1960, extensions of fisheries jurisdictions by both countries to 12 miles (in 1964 and 1966) and eventual negotiation, in 1970, of a Reciprocal Fishing Agreement which limited fishing by each other's nationals in areas of extended jurisdiction;

- Expansion of Canadian troll fishing (particularly off the west coast of Vancouver Island) and of United States troll fisheries off Alaska both known to intercept salmon bound for the other country.

Concerns about escalating interceptions were an important reason for the two countries to convene a second conference on Coordination of Fisheries Regulations in April 1959. The conference led to agreements for exchange of data and joint study of information on salmon interceptions near the northern British Columbia/Southeast Alaska boundary. Desultory and sporadic discussions regarding interception problems took place throughout the 1960's.

Throughout the 1970's, changes in the status of waters off the respective coasts of the two countries led to a series of negotiations of reciprocal fishing privileges. These culminated in 1977-1978 when both countries extended their fisheries jurisdictions to 200 miles. In the end, the two countries could not find a common basis for permitting fishermen of the other country to fish in the newly extended zones and as a result, with the exception of access for fishing for albacore tuna, both

countries have since excluded fishermen of the other country from their respective waters.

At the same time, problems associated with salmon interceptions worsened; neither country was prepared to place unilateral restriction on intercepting fisheries. In 1971 the two countries decided to attempt to solve these difficulties through the negotiation of a comprehensive coast-wide agreement.

The 1970 decade was a period of remarkable natural and technological and political changes that put great pressure on the governments to conclude an agreement. Events of significance included:

- Continuation of trends towards greater efficiency and mobility of the salmon fishing fleets which gave fishermen in both countries the power to inflict substantial damage on runs of salmon bound for the other country;
- Increased Canadian fishing on Fraser-bound sockeye and pink salmon outside the Fraser Convention Area and increasing frequency of diversion of Fraser-bound salmon through Johnstone Straits;
- United States legal requirements to divide Fraser River catches amongst United States citizens and lack of mechanisms within the Fraser Convention to meet such requirements;
- Expansion of Canadian fisheries in Canadian sections of transboundary rivers in Southeast Alaska area;
- Towards the end of the 1970's, a well-defined and steady decline in yields from natural chinook salmon stocks on a coast-

wide basis that was clearly the result of excessive competitive exploitation by fishermen of both countries.

- Breakthroughs in both countries in hatchery and artificial spawning ground technologies which promised to give both sides valuable tools for increasing production through artificial means. Since most major enhancement opportunities involved the production of salmon that would be vulnerable to capture by fishermen of the other country, however, budgetary authorities in both countries were reluctant to support new enhancement without an international agreement to protect the incremental production from interception.

These events gave important impetus to the negotiations. Embracing an immense range of extremely complex and contentious issues, the negotiations were finally concluded successfully in January 1985 with signature of the "Treaty between the Government of Canada and the Government of the United States of America concerning Pacific Salmon." The Treaty was ratified and came into force in March of the same year and now provides the basis for the two countries to cooperate on the control of intercepting fisheries and on enhancement for mutual benefit.

APPENDIX 3

REFLECTIONS ON PRIORITY INFORMATION AND TECHNICAL NEEDS

By D. L. Alverson

APPENDIX 3

REFLECTIONS ON PRIORITY INFORMATION AND TECHNICAL NEEDS

The main consultants' report attempts to outline structural changes required to facilitate information flow as well as generic research needed to carry out the Commission's work. The presentation avoids recommending specific priority actions while focusing on what was perceived to be the information needs required to meet treaty obligations. The following narrative constitutes a more free-wheeling and candid personal reflection on administrative and technical problems which will face the Commission over the next several years.

From my perspective, the success of the new Commission and its ability to meet the principles and goals of the Treaty will rest on the evolution of an effective communication system among the various management agencies and scientists involved and the Commission. Treaties, agreements and business arrangements frequently fail because;

1. Participants hold different views about the meaning and scope of the obligations set forth in an agreement.

2. The quality of the information used to evaluate performance is suspect by one or both parties to the agreement.

3. The results of research and/or statistical information used in fisheries management are not effectively communicated to the other party.

4. Methods used in the evaluation of performance differ, raising questions regarding the underlying assumptions and the precision and accuracy of findings.

5. A reluctance grows on one side or the other to perform because one or both parties do not feel that the obligations of the agreement are being met or do not benefit them.

6. The funds necessary to carry out the Treaty obligations do not materialize as anticipated.

Although the PSC has gotten off to a good start, to some extent each of the above noted "potentials for failure" must be dealt with by the Commission. The protracted negotiating period leading up to the new Treaty has left (on each side of the border) a residue of skeptics, doubters and a "wait and see" attitude among many scientists and administrative leaders. They are not quite sure that the relevant facts, statistics, etc. will be provided as required or that national sections will live up to their commitments. These dissidents can only be converted by dealing effectively with the array of problems identified above; and unless they are converted, they pose a serious threat to long-term success of the Commission.

In our discussions with various technical individuals involved with Commission work, it became obvious that some interpretative disparity existed between those in the trenches

and administrators responsible for the Treaty language Any interpretative differences should not be set aside or left to linger as uncertainties but should be cleared up as soon as is possible so that the technical work can proceed without skirmishes over the precise meaning of Treaty language.

These differences in interpretation reflect, to some degree, personal biases and expectations, but they also point to an early communication problem among the contemporary players. This is further evidenced by expressed confusion in the nature, timing and format of reports to be exchanged and by different views regarding reporting channels to and from the Commission. As noted in the body of our report, establishing effective lines of communication and data formatting may simply involve start-up problems, but they need the Commission's immediate attention.

From my experience during the negotiation period and my reading of historical documents concerned with the Treaty, a great deal of time was spent trying to sort out problems involved with the quality of information available on catches, debating data concerned with interception rates, catch figures for segments of commercial, recreational and subsistence fisheries, adjusting catches to different periods of their life history and estimating non-catch mortalities and escapement levels. The lack of quality data bases allows the scientists on each side of the border to interpret the information available in a manner most acceptable to his or her national interest. (Heaven forbid, we may have more national advocates than scientists.) I would like

to assume that these national biases have now been purged and that we will all go forward with lily white hands, but it won't happen. Such differences, however, can be minimized if the Commission and associated scientists place great emphasis at this point in the Commission's evolution on standardizing and/or setting up catch and effort data to allow for easy comparison of the information collected. In a similar vein, methodologies for stock identification, escapement enumeration, resource forecasting, etc. should be jointly evaluated by the parties with the goal of employing standardized techniques where feasible and to agreeing on the nature and implication of the underlying assumption of common and different approaches. Every effort should be made now to dispose of the concerns of the scientists on one side with the approaches of the scientists of the other. There are, of course, legitimate reasons to approach a common problem using different methodologies, but frequently these differences boil down to personal gratification. We will have a plethora of problems without returning to arguments over data bases and methods. Force the scientists to butt heads and deal with these differences now rather than after they become a major basis for confrontation (or subtly poison conclusions based on slanted information).

Much of the concern over the ability of each side to perform with respect to management regimes, regulations, etc. can be addressed by improving communications, data bases and agreements on research methods. However, the broader concerns as to how

well the parties will honor the commitment to optimize production require special attention. Most of the user groups supported the Treaty, assuming that there would be more rational and equitable fishing activities and, more importantly, that eventually more fish would be available to all user groups. Many of you will recall that the goal of more fish was frequently met (by commercial and sports fishermen as well as Indian tribes) with skepticism and claims of "paper fish." If the Treaty does nothing more than divide current levels of harvest between the two countries, it will be seen as a failure by many--including yours truly. Thus the issue of increased productivity needs the Commission's focus. I would agree that there are many paths we can follow to attaining this goal and will comment on such paths later. Nevertheless, the longer we procrastinate on formulating specific programs to meet this goal, the more ammunition we will provide those who would like to scuttle the Treaty.

This leads me to the matter of national funding of programs required to meet the Commission's objectives. The Commission and national sections are currently addressing the issues of establishing research priorities to cope with limited funding--certainly an important task. Perhaps, however, a greater concern is whether or not there will be adequate funds, (even for well thought out research programs), to carry out the Treaty obligations.

The Commissioners should avoid becoming the guardians of national austerity programs--there will be enough bureaucrats

around to carry that message. Rather, they should concern themselves with insuring that the respective governments fully understand the funding requirements needed to meet the conservation and production commitments subscribed to by the parties. In this sense, a full scoping of the longer term enhancement requirements--either natural or artificial--and potential benefits resulting from such funding should be undertaken. I doubt there is enough money in the current national budgets concerned with the PSC to fully meet Treaty obligations and thus reap the benefits of increased production and the vital public support that would follow.

All this, obviously, leads you to wonder if the issue of research priorities will ever be addressed. Yes, it follows below.

First let me address the subject of the Commission's structure in terms of facilitating information flow, formulating views on research and information needs and monitoring progress of the Commission. In order to be responsive to technical and administrative requirements, a host of committees, subcommittees, working groups, etc. have been established. Most seem to have a direct linkage to the Commission. This will make the work of the Commissioners very difficult. It will also insure the rise of independent fiefdoms among the technical groups--a bad management concept. The technical committees should be responsible to the R&S Committee. Reports and findings of the various committees should be submitted to the panels and Commissions unedited by the

R&S Committee but the latter should provide advice to the Commission and work with other committees to develop overviews on research and technical needs of the Commission and to suggest broader based technical cooperation and interfacing between the scientists of U.S. and Canada. Finally, the R&S should provide guidance to the technical committees on use of common terminology, report formatting, reporting procedures, etc.

In regard to research projects, I shall not differentiate between short and long-term research needs which, for the most part, are not mutually exclusive.

From both an historical and contemporary view "run reconstruction" constitutes the most important research activity which must be addressed by the Commission. This, of course, circumscribes a host of activities including identifying the origin of catches, quantifying catches and escapement, and allocating mortalities throughout a run's history. Current efforts are strongly focused on stock identification of catches and fisheries monitoring. At the other end of the spectrum, more effort should be given to evaluating the myriad of procedures for counting and estimating spawning escapement and to developing more reliable escapement counts.

The stock identification work is currently being planned for a number of species and localities. The Commission should continue to support these efforts. Special attention, however, should be given to sorting out problems associated with coho salmon along the two boundary areas.

In addition to catch and escapement enumeration, another aspect of run reconstruction is the incidental mortality associated with fishing. This has and will continue to be a controversial issue. Give this topic high priority.

Within the Fraser River system a number of problems remain with respect to stock identification but probably the most crucial issue will be getting a better handle on run diversion and timing which may reflect annual changes in behavioral patterns. Inability to cope with annual and cyclic variations in migratory patterns and the timing of runs will make it difficult to carry out the annual national catch allocations or achieve escapement goals. Continued efforts to sort out problems associated with changing availability of runs need the Commission's attention.

Planning for increased production should begin immediately. The following actions seem desirable. 1) Establish an information system and performance evaluation for hatchery and other enhancement activities. 2) Examine and catalog national potentials for increased production. 3) Establish a mechanism to jointly consider enhancement options and the international implications of most likely enhancement projects. 4) Develop an in-depth Commission report setting out options and the potential benefits of expanded production versus costs.

Finally, I would urge that the national sections dedicate more time developing the models for stock recruitment relation-

ship and resource forecasting. Joint and cooperative efforts should be promoted.

In closing, I would urge again that the Commission continue and expand its early efforts to bring together the scientists of the two parties in order to jointly explore means of improving the fishery data base, developing common methodologies and promoting joint and cooperative research efforts. The pooling of talents and developing of common respect among the various scientists will enhance the Commissioners' ability to meet its short and long-term goals and the level of public and governmental support for its work.

APPENDIX 4

STRUCTURING OF RESEARCH IN SUPPORT OF THE PACIFIC SALMON TREATY

By M. P. Shepard

APPENDIX 4

STRUCTURING OF RESEARCH IN SUPPORT OF THE PACIFIC SALMON TREATY

1.0 BACKGROUND

At its September 18-19, 1986 meeting, the Research and Statistics Committee of the Pacific Salmon Commission reviewed the main consultants' report and indicated a desire for a more specific appraisal of research requirements than had been called for in the Statement of Work (as amplified through discussions held in Seattle on July 11). Appendix 3, prepared in response to this request provides an overview of one of the consultant's (D.L. Alverson) view of priority concerns with respect to the conduct of research related to the Treaty. Both consultants subscribe to the views expressed in Dr. Alverson's presentation.

The present appendix expresses the author's (M.P. Shepard) views on the intent of the Parties with respect to the objectives of the Treaty and on the most appropriate approaches to the conduct of research aimed at achieving those objectives. Where possible, attempts have been made to minimize duplication of information and views developed in the main report. Nevertheless, for the sake of continuity, in a number of places in the present appendix, ideas or suggestions contained in the main report have been re-introduced.

2. CONSULTANTS' APPROACH

The consultant understands that the prime purpose of the present study is to assist in the initiation of a process for

establishing a long-term research plan for the Commission. In discussions with members of the Research and Statistics Committee, some expressed the hope that a draft "blueprint" could be prepared outlining the consultants' views on what a long-term research program should contain.

In the course of their month-long discussions with participants in PSC, the consultants came to the conclusion that it was premature to attempt to develop a scientific blueprint. The two principal reasons for this view were that:

- Research in support of the Treaty is being done in a piece-meal fashion (by species and by geographic area). There is no comprehensive picture of the issues towards which research is being addressed and no comprehensive appraisal of the adequacy of the programs. Such an appraisal would require much intensive work on the part of techical specialists of the two countries; it certainly could not be accomplished within the framework of the present short review.

- Present efforts within the Commission (both administrative and technical) are devoted largely to the implementation and negotiation of short-term fishing plans. As yet there has been little work done to articulate longer-term objectives. Without knowing the aspirations of the Parties with respect to the long-term implementation of the Treaty, it is difficult to determine what long-term research is required.

On the basis of these conclusions, the consultant believes that, rather than attempting to develop a list of specific

research activities that would make up a long-term research program, the first step would be to set in motion activities within the Commission which would:

- Consolidate research-oriented activities within the Commission to facilitate an a cross-species, cross-area, cross-committee review of present research activities.
- Comprehensively review current problems facing the Commission, characterize research required to solve the problems, determine the adequacy of present information and indicate further work required.
- Begin an cooperative effort to conceptualize and develop an array of long-term options for future development of the salmon resources relevant to the Treaty.

On the basis of such reviews, technical specialists within the Commission would then be in a position to articulate the research questions that would have to be answered to solve existing short-term problems and to lay the basis for critical examination of long-term options and for practical planning of those selected for implementation by the Parties.

The concluding sections of this appendix provide the consultants' views on the review activities outlined above. Before providing such comments, however, it would seem appropriate to outline some general perceptions regarding evolutionary patterns in North American salmon research and on the general question of research emphasis.

3. PATTERNS OF RESEARCH

When working actively in the field, there is a tendency to view research activity as a rather stable or slowly evolving process following a single path. In fact, research activity tends to progress in a discontinuous way, with rather sudden changes of emphasis taking place from time to time in response to external demands. In planning research in the long term, it is perhaps useful to consider patterns of activities that have occurred in the past as a guide to what might happen in the future.

North American research on Pacific salmon has followed two more or less parallel courses. The first involves work to support the development of enhancement technology and the second studies of the fisheries themselves and their effects and those of environmental factors on salmon production. Technical work supporting enhancement began early (with the establishment of the first Pacific coast hatchery in 1870). It was not until the second decade of the twentieth century that research on the second mainstream, fisheries and the natural stocks, began in earnest. It is curious that, to a considerable extent, work in the two fields has proceeded virtually independently. This schism has created serious difficulties in the conduct of research programs and in the development of comprehensive management regimes.

3.1 Enhancement technology

Whereas the Treaty is very much concerned with the results of enhancement activity (including the anticipation of what enhancement projects will produce in the future), it is not concerned with the development of technology (the development of enhancement techniques) per se. Such technological development remains the preserve of the Parties. For this reason, the present report will not deal with the technological aspects of enhancement except to point out that there are many unresolved questions in the field with respect to cost effectiveness, controlability and reliability. The recent failure of a number of enhancement projects with long histories of high production underlines the fact that factors influencing the success or failure of enhancement projects are still not well understood. Such uncertainty has important implications for implementation of the Treaty and would invite cooperative efforts by the Parties, within or without the Commission to push knowledge forward in this field. In this regard, as outlined in the main report,

" ... it would seem desirable to use the umbrella of the commission to foster cooperative work between specialists in the two countries to improve existing enhancement technologies and to develop new ones."

Whereas the study of enhancement technology is not in the direct line of the Treaty's activities, the impact of technically successful enhancement on fisheries is a matter of great importance to the Parties in implementing the agreement. Indeed, the

Treaty places specific requirements on the Parties with respect to the planning, conduct and assessment of the results of enhancement-activities. Work to assess enhancement activities (e.g. CWT programs) is also a major contributor to knowledge of migrations and exploration rates, a field of vital importance for implementation of the Treaty. Identification of enhancement opportunities (inventories) will play a major role in future indicative planning. All these activities are intrinsically related to fisheries management issues and are therefore discussed along with the latter in succeeding sections of this appendix.

3.2 Research on Fisheries and Natural Stocks

The main field of research of relevance to the Treaty is the study of the fisheries themselves and on environmental factors affecting them. To date there have been four general phases, beginning in earnest in the second decade of the century with basic work on life history (e.g. studies of size and age, survival rates at different stages and on the effects of environment factors on survival). These studies concentrated on factors affecting the productivity of salmon both in freshwater and at sea. This stage lasted into the 1960s. Since then the emphasis of salmon research has switched from studies of basic production factors to more fishery management oriented activity. After World War II, intensification and spread of the salmon fisheries began to cause concern, ushering in a stage of information gathering and research in support of the development of manage-

ment principles. This phase which began on a substantial scale in the 1940s was characterized by improved monitoring of fisheries (the development of comprehensive fisheries statistical systems), development of stock and recruitment theory and of systems for fisheries regulations to control exploitation. Management systems were developed in a number of areas, the most notable of which was international control of sockeye fisheries in the Fraser River Convention Area. The intensification of mixed stock fisheries in the late 1950s through the 1970s created a need for the third phase--studies of migrations. Information on migratory patterns, derived from marine tagging and studies of distinctive scale, meristic, morphometric, parasite, and protein chemistry characteristics was required to provide the basis for more attempts to develop more comprehensive management programs to protect the stocks from increasingly widespread and intensive fishing. The actual management measures employed tended to be primitive and, lacking institutional frameworks for cooperation between jurisdictions (Canada/United States, between States and between State and Federal agencies), were often ineffective. The development of new arrangements through the FCMA and the Pacific Salmon Treaty have provided improved pathways for cooperation and opportunities to develop more comprehensive approaches to management. In the 1980s these developments ushered in the fourth and most recent stage of research activity--the development of comprehensive management systems characterized by the development of models to assess the consequences of applying

alternative regulatory measures and of changes in stock strengths, the development of index systems for measuring stock performance, etc.

Activities characterized as the third and fourth stages above (migrations and management systems) presently represent the principal research activities of technical staffs of both countries involved in implementation of the Treaty. It is hoped, however, that this represents a stabilizing phase that can presage the beginning of a fifth stage involving research to develop an improved understanding of factors affecting the productivity of the resource, essentially a return to the type of work carried out during Phase 1. Such information will be needed if the full potential of the Treaty for strengthening the resource base and for improving its utilization for the benefit of fishermen in both countries is to be achieved.

4. RESEARCH EMPHASIS

It is the consultants' view that the central objective of the Treaty is contained in subparagraph 1a of Article III. Dealing with salmon stocks susceptible to fishing or to effects of fishing by both sides, the subparagraph requires that each Party "... conduct its fisheries and its enhancement programs so as to ... prevent overfishing and provide for optimum production." The parallel subparagraph 1b, which requires that the activities of the two countries "... provides for each Party to receive benefits equivalent to the production of salmon originating in its waters..." represents a ground rule or a constraint

that prescribes the method of sharing that the two sides will apply when working towards the principal goal of "optimizing" (in most cases meaning increasing) production.

Consistent with the view expressed in the foregoing paragraph, the consultant believes that research efforts under the Treaty should emphasize positive measures to "optimize" (i.e., increase) salmon production in a mutually beneficial way rather than to concentrate on work to identify the national origins of salmon in order buttress national scorecards aimed at quantifying estimates of who is "ahead" or "behind" in achieving benefits from interceptions of the other country's salmon resources.

This does not mean that the achievement of a balance of benefits or of ensuring that future changes in fishing patterns or fish production are carried out in an equitable manner are not important. Indeed, the Treaty cannot work unless its implementation can be viewed as just and fair by both Parties, i.e., that there is equity. The reason the consultant believes it appropriate to downplay the equity question at this stage of the Treaty's implementation, at least from a technical point of view, is that research aimed at improving management requires much of the same information that is required to identify the national origins of salmon for purposes of determining balances. As more and more results accrue from studies of stock production, evidence of the extent of interceptions will grow in an incidental way, providing a continuously improving background for the countries to consider equity problems.

In any event, the question of equity is not simply a biological one. Even if the Parties agreed completely on the quantities of salmon being intercepted on both sides, they would still have to transform such quantities into measurements of "benefits." As was demonstrated by vain attempts to develop common approaches to valuation of interceptions during the negotiations, differences in the interests and the economic and social values of the industries of the two countries make it extremely difficult to move from quantities of fish to weighted values of benefits received. In the end, the Commission's decisions regarding subparagraph III.1.b will be based on practical negotiations.

For this reason the consultant believes that technical efforts to develop means of weighing interceptions in terms of economic or social values (in order to provide specific measures of "benefits," pursuant to paragraph II.1.b are unlikely to lead to the development of agreed standards between the Parties and would therefore probably represent a waste of time and scarce technical resources. In the long-term, research aimed at improving the basis for cooperative management and development of fisheries in both the short and the long term should be accorded the highest priority.

5. REVIEW OF RESEARCH AND DEVELOPMENT OF SCENARIOS FOR THE FUTURE

As indicated in the introduction to this Appendix, the consultant believes that it is premature for the Commission to

embark upon the development of a detailed long-term plan before appraising the present status of the Commission's program and the research that is being conducted in support of it and before setting in motion steps to establish long-term objectives for management and development programs on both sides. To these ends a two pronged approach of comprehensive assessment of the existing situation coupled with the initiation of work to examine development scenarious is suggested. To facilitate the former, improvements in the institutional structure for consideration of research within the Commission would be desirable. The present section addresses the processes needed to carry out the recommended reviews.

5.1 Institutional Arrangements

As reflected in Tables 1-4 of the main consultants' report, it is apparent that the information requirements are immense in scope and complexity and, arising from different parts of the Treaty and its associated documents, are not organized in a systematic fashion. The need to provide some framework for reviewing research on progress and for future planning was undoubtedly a major reason for launching the present consultancy. The Commission and national agencies responsible for organizing work to support the Commission's program has found it extremely difficult during the critical start-up phase to address the question of ordering and prioritizing the diverse information requirements. As pointed out in the main consultants' report, the Commission's committee and working group framework is not

well structured to make consolidated appraisals (involving the structured participation of specialists dealing with particular aspects of treaty implementation) of the immense amount of work being conducted under the Treaty's auspices. The consultant strongly believes that better appraisal and planning of research depends to a considerable extent on improving the institutional arrangements for consideration of research. In this regard, the suggestion in the main consultants' report is reiterated, namely that:

> " ... representatives of technical committees ... participate with the Research and Statistics Committee in preparing a review of current research results in assessments of future needs."

As experience is gained, consideration might be given to making more formal arrangements for structuring research considerations within the Commission so that the work of the Technical Committees is more closely integrated than that of the Research and Statistics Committee. Essentially, the consultant believes that the Research and Statistics Committee should be the focus of all information collection, analysis and reporting for the Commission and that the Technical Committees should operate in a subsidiary role. At the same time it is recognized that there is considerable value in maintaining the ready accessibility of the Technical Committees to the Panels. The necessary linkages can be achieved, as suggested above, by making the Research and Statistics more of a "Committee of the whole" with its main

participants being representatives of the Technical Committees. In this way, common approaches and appraisals of programs, etc. would involve peer group review and the development of consensus rather than the present situation wherein the Research and Statistics Committee and the Technical Committee can operate separately and potentially in competition without a mandate to develop common opinions.

5.2 Review of Current Issues and Research

As outlined in the introduction to this appendix, the consultant believes that the appraisal referred to in the quotation above is a prerequisite for the development of any future long-term research plan. The appraisal should concentrate on identifying the technical issues raised by the Treaty, the research questions posed by these issues and the approaches and programs being used to answer such questions. Such an approach would be preferable to a project-by-project review such as the consultants believe is being considered by the Research and Statistics Committee, at least at the present stage of development of the Commission's program. Such a review by project would concentrate attention on what is being done now rather than on what should be done.

The review contemplated by the consultant would begin with a characterization of the technical issues posed by the Treaty. Considering the Treaty's objectives of ensuring adequate conservation (preventing overfishing and optimizing production) and equitable sharing, the first issue is to determine the magnitude

and extent of exploitation of stocks or stock complexes (both natural and enhanced) subject to provisions of the Treaty. Such determinations require information on:

- Distribution of the stocks (both natural and enhanced) among fishing areas.
- Removals in the fisheries (both fish harvested and fish killed incidentally and discarded or lost).
- Escapements to the spawning grounds.

When an appraisal has been made of the factual background, potential problems related to conservation or to sharing can be examined. In this regard, the fishing regimes established in Annex 4 (some to be renegotiated this year) were intended to move towards meeting the objectives of the Treaty. The extent to which they do so should be examined.

Both past and future fishing regimes depend on:

- Assessment by the state of origin (except for the Transboundary stock for which there is bilateral responsibility) of escapement or haresting rate requirements.
- Knowledge of the potential harvesting capacity of fisheries.
- On the basis of the foregoing, agreed decisions on total removals or interceptions or on allowable harvest rates in specified fisheries.
- In-season control of fisheries to maintain established limits.

All except the third of the foregoing represent assessments or actions of the state of origin or the fishing state. Nevertheless, the setting of escapement targets and the development of national fishing plans require the development of mutual confidence if the Treaty is to be implemented successfully. Discussions within the Commission of such issues is therefore considered to be appropriate and necessary.

As discussed in Section 4 of the main report, a broad spectrum of information is required to support the practical implementation of fishing regimes. The review should assess the adequacy of information provision for these purposes and highlight technical problems, e.g. problems in protecting small stocks which are fished along with large stocks.

Separate reviews should be completed for each of the sets of stocks given separate treatment in Annex 4 (i.e. Transboundary, Northern Boundary, chinook, coho and southern chums).

Finally, the coverage of the individual sections should be renewed in a consolidated way to identify common problems and opportunities for cross species/area/committee cooperation. Such cooperation would seem to be particularly appropriate with respect to teh development of analytical techniques (e.g. stock ID and modeling).

Most of the elements listed above were covered in Section 4 of the main report. The following sections provide some supplementary views on the issues.

5.2.2. Information on origins

The first issue mentioned above was the development of information on the origins of salmon in intercepting fisheries and information on the timing and routes of migration of salmon. Studies on migrations and stocks have been the principal field of research that has occupied technical specialists of the two sides in recent years. During the consultants' interviews with officials in both countries effective planning of research in the stock ID field represented a major concern. The focus of the question is the degree to which interceptions of salmon can be determined and monitored. Such information is becoming of increasing importance as the Parties begin to negotiate new fishing regimes for a number of fisheries.

Stocks subject to the Treaty are defined as those subject to interception or which affect the management of stocks in the other country or which biologically affect stocks of the other country. Beginning in the early 1970s, as background for the negotiation of the Treaty, technical specialists of the two countries regularly summarized their best appraisals of the extent of interceptions in the fisheries. The interpretations of the two sides frequently differed and such differences were recorded in the reports of the specialists. The last such report covered the 1979 season. Most of the technical analyses for the summaries were carried out in the early 1970s and for the latter part of the decade, the reports just used percentage interception figures from the earlier work. Time and effort was not available to take into account considerable new information that came to

light after the mid 1970s. Thus the data for the later years of the reports were clearly out of date.

Despite their shortcomings, the 1970-1978 "interception reports" provided a most useful background for the negotiating teams of the two sides, particularly in proving a perspective of the relative importance of individual fisheries from the interception point of view.

Preparation of such reports covering recent years would seem to be most useful for providing the Commission and national funding agencies with a weighted picture (at least in terms of quantities of fish) of the extent of interceptions (an important consideration in assigning priorities), and of remaining differences between specialists of the two countries in interpretation of the data. For maximum utility such tabular material would have to be buttressed by a description of the methodologies used to derive estimates and on their confidence limits. The latter again should permit focusing attention on remaining problem areas as background for priority decisions.

Such a report would provide a useful background for the review of stock ID technology proposed by the consultants in Section 4.1.2 of the main report.

5.2.2 Escapements

As will be discussed later, improved information on the abundance of spawners is a key element in developing better understandings of factors affecting long-term productivity. Even in the short-term, however, escapement data are extremely

important: the principal objective of fishing plans developed through the Treaty is the provision of target levels of escapements. There are great differences in methodologies used to estimate or to index escapements in different areas, which makes it extremely difficult to make comparisons and to link activities in the different areas within cooperative programs. As time goes by the importance of escapement data will increase.

The overall review would look at the particular uses being made of escapement information within the Treaty. In addition, however, there would seem to be an additional need for technical agencies in both countries to work to develop comparable, consistent techniques for estimating escapements. The development of new technology may be required.

Considering the expense of escapement estimating techniques, the use of approaches involving indexing of stocks would seem to hold considerable promise. This is discussed in more detail in the section dealing with analytical techniques below.

5.2.3 Forecasting

In the main report, information on environmental availability, variability in migration patterns and environmental and behavioral effects on fishing were discussed. All of these are of greatest importance with respect to forecasting.

The main purpose of forecasting is to facilitate the control of fishing: unexpected variations in abundance or migration paths can lead to mistakes in regulations which can, in turn lead to failure to achieve targets. Whereas preseason forecasting

work is useful, it would seem that in-season anticipatory information can be even more important. The use of test fishing (particularly ahead of fisheries) would seem to hold considerable promise and has the advantage of being able to support part of its own costs through sale of its catch. However, little disciplined scientific work has been done to develop in-season indexing methods. There would seem to be considerable value in examining possible cooperative work in this field.

5.2.4 Enhancement

The Treaty calls for regular consultation between the Parties regarding ongoing and planned enhancement projects. Little such consultation has as yet taken place, reflecting, in part, the situation existing in both countries wherein enhancement activities tend to be conducted relatively separately from fisheries management activities (the principal short-term concern of the Treaty).

Long-term cooperation in research related to enhancement is discussed in the section on long-term planning below. With respect to the short-term, however, enhancement operations play an immensely important part in research regarding migrations and harvest rates. Extensive coded-wire tagging of hatchery out-migrants represents the main tool for tracing the migrations and exploitation of chinook stocks. During the consultants interviews it was learned, however, that in many instances data gathered in the course of enhancement and associated CWT activities were not conducted in a manner that would make them of

maximum usefulness for migration and exploitation studies. Obviously closer coordination between technical planning for enhancement appraisals and for Treaty implementation will be required.

5.2.5 Development of analytical techniques

The foregoing sections have dealt with factual background material required to examine the technical questions posed by the Treaty. To apply such information to answering the questions requires the development of analytical systems. All the technical committees use modelling techniques to explore the consequences of varying strengths of stocks, fishing pressures, etc. Some of the systems are very complex, taking into account interactions between many fisheries and stocks. Others are relatively simple. Use of the models requires many assumptions and the conclusions that may be drawn from them are accordingly subject to the errors surrounding the assumptions.

As outlined in the main report, there would seem to be considerable virtue in cooperative efforts to develop working models of general utility for all committees, allowing for interactions between species and fisheries. Assessments of sources and magnitudes of errors involved in making estimates based on the models would be an important element in developing such models so that the reliability of estimates made can be characterized and taken into account by users.

Implementation of the Treaty will continuously require monitoring of the effects of fisheries regimes on the stocks.

Considering the complicated migration patterns and interrelated fisheries for stocks under the study, the job of monitoring is extremely difficult. To deal with the challenge, the concept of indicator stocks is being actively explored and used on a trial basis. This involves the selection of a group of stocks for which intensive information on escapements and contributions to fisheries (and harvest rates) can be collected effectively and assuming that such stocks are representative of other stocks within the same geographic area. This approach seems to be most worthwhile considering the major difficulties and great expense that is required to obtain such information for individual stocks. For maximum utility, however, it will be necessary to carry out substantial testing of hypotheses involved in establishing index systems, particularly with respect to relating findings for index stocks to other stocks within areas the index stocks are intended to represent. Considerable attention to cooperative development of the index approach would seem desirable.

5.2.6 Long-term studies of productivity

The foregoing sections have dealt mainly with information requirements to meet the very specific short-term commitments of the Treaty associated with the design and conduct of annual fishing plans.

As pointed out in the main consultants' report, it is the anticipation of fishing communities in both countries that implementation of the Treaty will, in the long term, result in a

substantial increase in the quantities of salmon available to the fleets. Although present short-term fishing plans have elements within them aimed at improving the condition of the stocks (particularly the chinook rebuilding program), they are not long-range and do not purport to be directed towards achieving substantial increases in production.

In the main, the Treaty leaves management decisions regarding establishment of escapement targets and decisions on enhancement projects to the Parties themselves (subject to the restraints of Article III). For this reasons the development of future management and enhancement strategies and the research required to support them might be viewed to be mainly matters of purely national concern. The consultant strongly believes, however, that because of the inter-relationships between the stocks and the fisheries of the two countries and of the desirability of harnessing the combined technical skills of the two countries, it will be essential for the Parties to work closely in studies of productivity of the resources, in setting future production targets and in devising plans for the rational harvest of such production.

As outlined in the main report (which will not be treated in greater detail here), work that may be required would include development of:

- Improved understandings of the relationships between escapements and resultant production;

- Improved understandings of the productive limitations of the freshwater and marine environments and of the effects of environmental factors on production;

- Better understandings of the productive potential and economics of alternative enhancement technologies.

As outlined in Section 4.2 of the main report, it would seem appropriate for technical specialists of the two countries to begin a dialogue on the state of knowledge of factors affecting the abundance of salmon as background for possible future measures to increase production. Examination of the stock-recruitment relationship would be a key focus for such considerations. The main report indicates that studies of historic catch statistics could provide valuable insights into such relationships. Many other open questions exist, however. These include:

- Whether or not stock/recruitment relationships are constant or whether they vary depending on the current status of the resource (do optimum escapement levels change as populations are rebuilt from depressed levels?).

- Inter and intra-specific competition or other related factors which leading to brood year variations of a cyclic nature or which possible lead to suppression of production of runs to some areas and burgeoning production in others (the continued depressed condition of U.S.S.R. chum salmon in the face of great increases in Japanese production could be a case in point).

With certain exceptions, it has been many years (essentially since the first phase described in Section 3 above) that research

in either country has focused on such fundamental considerations related to the productivity of the resources. There would seem to be an important need to again launch studies aimed at partitioning the life history of salmon and examining factors affecting survival and growth at each stage. Fisheries research technology has developed greatly in the last 15 years; application of new techniques (e.g. for detecting and capturing fish, for ageing fish and for analyzing and processing data) should give modern investigators major advantages over their predecessors conducting most of their studies several decades ago. The consultations on the existing state of knowledge of productivity proposed above should provide useful guidance for both national and cooperative research programs in this field.

5.3 Development of Long-Term Scenarios

To provide a framework for longer-term research, there is a need for the Commission to establish a focus for consideration of possible long-term changes in stock composition and in fisheries as the result of management or enhancement activities that may be undertaken by the Parties in the future. As outlined above, one of the major benefits envisaged by the Parties to flow from the Treaty was the ability to increase certain stocks with the assurance that the benefits would accrue to the host country. The sockeye stocks of the Fraser and the chinooks of Washington and Oregon are the most prominent examples. The achievement of objectives involving major changes in stocks and/or fisheries

will require the greatest care in planning. Such planning should begin now.

On the basis of the foregoing, the consultant recommends that the Commission establish a long-term policy development group to begin to develop scenarios for possible long-term increases in production. Such a group should be supported by appropriate technical experts. Initially the group might:

- Review aspirations of both Parties for possible long-term resource developments (to be brought about either through improved management or through enhancement) or changes in fisheries;
- Determine the consequences of such developments with respect to increased production, availability of fish in fishing areas of both countries and the impact of fishing regimes;
- Identify information needed to make more precise evaluations of the potential productivity of the resources and of their utilization.

It is evident that, in its initial stages at least the work of such a group would have to be informal; in the interest of encouraging freewheeling consideration of possible developments, scenarios considered by the group would not necessarily have to represent official submissions by either side.

The deliberations of this group should provide a fruitful basis for planning of long-term research by the Parties both on a national basis and cooperatively through the Research and Statistics Committee. The group's work should bring into sharp

focus gaps in knowledge that will have to be filled if the long-term aspirations of the Parties are to be realized. It would be expected that the group would ask some fundamental questions concerning the efficacy of enhancement techniques (from both a biological and an economic point of view) and concerning factors limiting productivity.

The Research and Statistics Committee could appoint its own long-term planning group to work with the broader group in a complementary manner.

5.4 Doubt and Certainty in Science

In almost any fisheries community dealing with management issues, scientists are asked to provide an immense amount of information to managers and to private sector advisors. Much of the information is based on assumptions, many of which are tenuous. There is usually a wide range of error associated with estimates (e.g. optimum escapements or predicted abundance of returning runs).

Practical managers would usually prefer not to consider such ranges of error, wanting "the number" on which to base their decisions. Scientists usually attempt to comply. However when events produce results differing from "the number," scientists are often critized and doubt is cast on the usefulness of their work.

The Commission with its Panel and Committee structure provides an excellent opportunity for fruitful interactions between scientists, administrators and resource users. To

develop mutual confidence there would seem to be a need for all to develop a common understanding of the variability and dependability or undependability of information. To this end more scientific efforts should be expended to develop estimates of error around numbers provided as a basis for management decisions (the Data Sharing Committee is addressing this question) and the managers and private sector participants should be more prepared to accept "soft" quantifications with understandings that every estimate is subject to error. In this way, rigid formulations (such as those involved in present rebuilding programs or in annual performance under fishing regimes) would be viewed with more flexibility than at present. Indeed, it would seem appropriate if the Commission were to address the question of forming future regimes in more flexible terms (i.e. with allowances for error) than has been the case in the past.

6. SUMMARY AND CONCLUSIONS

- At the present time, research activities under the Commission are focused in numerous individual technical committees. There is no overall outline of the research issues that are being addressed and no comprehensive cross-species, cross-area, cross-committee, review of the adequacy of present research efforts.

- The Commission has not established specific long-term objectives for its activities and most effort within the Commission has been directed to the ad hoc job of implementing annual

fishing regimes and in preparing to negotiate new short-term arrangements.

- Under such circumstances it is premature to develop a specific long-term plan for research.

- Instead, it is recommended that the Commission undertake a two-pronged approach to lay the groundwork for long-term planning involving:

- Undertaking of a review summarizing available information of the distribution of stocks among fishing areas, the extent of removals and the abundance of escapements; such information to be related to the short-term requirements of the Treaty regarding the elaboration and implementation of fishing and enhancement plans.

- Initiation of cooperative work to develop a list option for future long-term management and development programs and to assess the implication of such programs with respect to the Treaty.

- On the basis of information from the foregoing, long-term research questions can be identified and a development of a plan initiated.

- Studies of factors influencing the productivity of salmon are only of limited direct relevance to the Treaty. However, both Parties require a better knowledge base in order to bring about improved management and development and cooperative efforts in this direction, under the auspices of the Commission would seem most desirable.