NORTH PACIFIC ANADROMOUS
FISH COMMISSION

北太平洋溯河性魚類委員会

КОМИССИЯ ПО АНАДРОМНЫМ РЫБАМ
СЕВЕРНОЙ ЧАСТИ ТИХОГО ОКЕАНА

Science Plan 1997-98

Committee on Scientific Research and Statistics, Chairperson Loh-Lee Low
Science Sub-Committee, Chairperson Michael Dahlberg

North Pacific Anadromous Fish Commission
Secretariat

6640 NW Marine Drive
Vancouver, B.C. V6T 1X2
Canada

Tel: (604)228-1128
Fax: (604)228-1135

Irina Shestakova, Executive Director

July 1997

The Commission

members....Canada, Japan, the Russian Federation, and the United States....

The North Pacific Anadromous Fish Commission (NPAFC) was founded by the Convention for the Conservation of Anadromous Stocks in the North Pacific Ocean. The Parties of the Commission are Canada, Japan, the Russian Federation and the United States of America. The primary objective of the Commission is to promote the conservation of anadromous stocks in the Convention Area. Anadromous fish stocks are the six Pacific salmon species (chum, coho, pink, sockeye, chinook, cherry) and steelhead trout. The Convention Area is the waters of the North Pacific Ocean and its adjacent seas, north of 33 degrees North Latitude beyond 200 nautical miles from the baselines from which the breadth of the territorial sea is measured.

The scientific work of the Commission is carried out by the member Parties through coordination by the Commission's Committee on Scientific Research and Statistics (CSRS). The CSRS has established the following ad hoc groups to carry out its activities for 1997-98: a Science Sub-Committee to develop and implement the Commission's science plan, and working groups on (1) standardization of methodology, (2) stock identification and growth, (3) stock assessment, and (4) format of the statistical yearbook.

The Science Plan

....two critical issues....

At the 1995 annual meeting of the Commission, the CSRS identified the following two critical issues for research by the Parties: (1) factors affecting current trends in ocean productivity in the North Pacific Ocean and their impacts on salmonid carrying capacity, and (2) factors affecting changes in biological characteristics (growth, size and age at maturity, oceanic distribution, survival, and abundance) of Pacific salmon. In 1997, the research planning and coordinating group reviewed each party's planned research activities that are related to these two issues and, based on these planned activities, developed a revised NPAFC Science Plan.

....three components....

The NPAFC Science Plan consists of three components of research: (1) salmonid life history, (2) salmonid population dynamics, and (3) salmonid habitat and ecosystem. Each component has several items that identify questions relating to the two critical issues. The questions are to be clarified by coordinated research of the Parties. Each year, new questions may be raised, and the Science Plan will be revised accordingly.

A revised plan was developed for 1997-98 because of short-term budget considerations of each Party. It is the intent of the Parties to conduct research over the next three years to address the following types of questions:

1. Life History of Salmonids

1.1 Spatial Distribution

- When and where do salmon concentrate in highest density?
- Does sea surface temperature regulate salmon distribution?
- Does interaction between different species and different stocks affect the distribution?
- Are juvenile salmon distributed in oceanographically protected waters?
- Is salmon distribution related to distribution of predators or competitors?
- Do oceanographic conditions and productivity of food organisms affect salmonid distribution, and is there a trend in this influence at various periods during their life history?

1.2 Growth and Maturity

- When and where does growth variation of salmon occur?
- Which life history stage is the most important for determining growth variation (juvenile, immature, maturing, or returning adult)?
- What factors (salmon density, sea temperature, food resources, competitors, predators) affect growth variation?
- How does growth variation affect maturation and reproduction?

1.3 Feeding Ecology (Diet)

- Is salmon diet species-specific?
- Is the composition of food specific to salmon species?
- Does salmon diet change by salmon density?
- Does salmon diet reflect the abundance of food items?
- Does salmon diet affect salmon growth, and survival?
- Does salmon diet relate to salmon distribution and population numbers?
- Does salmon abundance regulate food supply or does food supply regulate salmon abundance?

2. Population Dynamics

2.1 Abundance, Monitoring, and Forecasting

- Does salmon abundance on the high seas provide a good estimate of adult returns? Where and when?
- What are the most important and effective monitoring items?
- How can carrying capacity be estimated?
- What determines changes in carrying capacity of salmon?
- How can a strategy of forecasting be determined for the commercial returns in various populations?
- What factors are related to changes in carrying capacity?
  a) Do changes in carrying capacity alter salmon abundance and production?
  b) What are the environmental variables that control carrying capacity?
  c) Does carrying capacity change with changing climate? If so, by what mechanism?
- Can the Ricker model be used to estimate the carrying capacity of salmon?

2.2 Mortality

- What factors are related to salmon survival (return rate)?
  a) Do predators and/or competitors affect salmon survival?
  b) What is the relationship among starvation, disease, temperature, and mortality?
  c) Does over-wintering affect mortality?
- Which period is critical for determining the abundance of the various species, populations, and age-groups?

2.3 Stock Interaction

- Does stock interaction affect growth, distribution, diet, and reproduction?

2.4 Stock Indentification

- Are baseline data (genetic, parasite, etc.) stable?
- What salmon stocks are identifiable with each of the various techniques?
- How accurate and precise are the stock identification estimates?

3. Salmon Habitat and Ecosystem

3.1 Physical-biological Interaction and Productivity

- Does the Aleutian Low affect production?
- Does salmon abundance affect productivity?
- Is productivity in the western, central, and eastern North Pacific different?

3.2 Climate Change Effects

- Does sea ice affect salmon production?
- What are the effects on southern distribution limits of salmon?
- What are the effects on food supply and predators of salmon?
- In what way do meteorological changes affect productivity? Is there a trend?

3.3 Regime Effects (Temporal and Spatial)

- How can regime shifts be detected?
- Are ancient salmon otoliths and scales available for retrospective analyses?
- Are regime shifts reflected in hard parts (scales, otoliths, etc.)?
- Are there other indicators (parameters) that permit tracking the changes?

Science Subcommittee

Members of the Science Subcommittee:

Canada - Richard Beamish
Japan - Kiyoshi Wakabayashi
Russia - Vladimir Karpenko
U.S.A. - Michael Dahlberg (Chairperson)

Cooperation

....with PICES-GLOBEC....

The Commission is cooperating with the North Pacific Marine Science Organization (PICES) to examine the two critical issues identified at the 1993 meeting. The Science Subcommittee of CSRS provides the technical liaison to coordinate the Commission's salmon reasearch activities with the PICES-Global Ocean Ecosystem Dynamics Studies (GLOBEC) international program on "Climate Change and Carrying Capacity" of the North Pacific Ocean.

....among the Parties....

The Parties of the Commission are also coordinating their respective research activities to address the issues identified in the Commission's Science Plan. Specific research activities for 1997-98 are described in the following sections.

Research by the Parties

NPAFC Science Plan for 1997-98
Research Activities of the Parties

Research Components	NPAFC Issue #1 Productivity, Carrying capacity				NPAFC Issue #2 Biology, Abundance, Distribution			
	Cdn	Jpn	Rus	US	Cdn	Jpn	Rus	US
1. Life History								
- Spatial Distribution	C-1	J-1		U-5	C-1	J-1	R-1	U-2 U-5
- Growth & Maturity	C-1			U-1 U-5	C-1	J-1	R-1	U-1 U-3 U-5
- Feeding Ecology	C-1			U-5	C-1	J-1	R-4	U-1 U-5
2. Population Dynamics								
- Abundance, monitoring, forecasting		J-2	R-3	U-5		J-2 J-3	R-3	U-1 U-5
- Mortality mechanisms			R-3			J-2	R-1	
- Stock Identification					C-4	J-3	R-2	U-4
- Stock Interactions	C-2			U-5	C-2	J-2		U-5
3. Salmonid Habitat and Ecosystem								
- Physical-biological interaction & productivity	C-1	J-3	R-4	U-2 U-5	C-1			U-5
- Climate change effects	C-1 C-3	J-2	R-4	U-5	C-3			U-5
- Regime effects (temporal & spatial)	C-3	J-1		U-5	C-3			U-5

Canadian Research Plan

C-1 Distribution, growth, and bioenergetics of salmon in the eastern North Pacific Ocean

Research will focus on obtaining a better understanding of the biological mechanisms underlying the sharp thermal limits on the distribution of Pacific salmon found in the Pacific Ocean. It is not clear why these thermal limits are as sharp as recent investigations have found, or what the implications are for oceanic influences on salmon productivity.

C-2 Stock and species interactions in the eastern North Pacific Ocean

One aspect of this research will focus on retrospective analysis of interannual variation and covariation in the size of fish in different salmon stocks, particularly sockeye salmon, in relation to abundance in the North Pacific. A second aspect of this work will be conducted using archival scale collections to identify annual rates of marine growth for different stocks, and to relate these rates of scale growth to changes in marine abundance of Pacific salmon and oceanographic conditions. In addition, comparative work on the relative trophic position and degree of trophic overlap of the different species will be conducted using stable isotopes as an index of feeding history.

C-3 Climate change vs. survival, Strait of Georgia, coho and chinook salmon

Canada (DFO) has funded a three-year multidisciplinary study of the biological and physical factors that affect the brood-year strength of Fraser River salmon stocks that pass through or reside in the Strait of Georgia. The emphasis of the study will be on chinook and coho, but there also appear to be impacts on chum, pink and sockeye. There is evidence that the shift in the ocean regime in 1976-77 that increased the productivity of salmon residing in the open Pacific Ocean had the opposite impact on the coastal area in the Strait of Georgia. Our hypothesis is that the carrying capacity for salmon that reside in the Strait of Georgia decreased because earlier spring plankton blooms improved the survival of species that spawned earlier in the year. These species would compete directly or indirectly with salmon for food. If our hypothesis turns out to be correct, there may be evidence of a trade-off between decreased coastal survival for salmon and improved high seas survival. In this study, the influence of hatchery-reared coho and chinook smolts on marine survival of wild smolts is also being investigated.

C-4 Stock identification (genetics, scales, etc.)

Current stock identification research is focusing on genetic techniques. In addition, baseline scale data continue to be collected for chum

salmon stock identification, and a study is being conducted on the use of parasites for stock identification among certain stocks of sockeye salmon. The genetic stock identification work is based on variability among stocks in nuclear DNA sequences. Microsatellite and minisatellite loci are being examined in chinook, coho, and sockeye salmon using the PCR (polymerase chain reaction). Variability in Class I and Class II genes of the Major Histocompatibility Complex (MHC) is also being examined using the PCR. MHC genes are involved in the immune response and are the most polymorphic coding genes of the vertebrate genome. Sequence variability in the exons (coding regions) and variable number tandem repeat (VNTR) variability in the introns (non-coding regions) of MHC genes are being examined for stock specificity in chinook and coho salmon.

Japanese Research Plan

J-1 Life history, distribution, growth, and feeding ecology

This set of studies is designed to address the following issues: Investigate the distribution of salmonids, by ocean age and maturity, based on data accumulated by research vessels in the North Pacific Ocean. Identify factors affecting salmonid distributions, such as ocean temperature and interactions with other species. Investigate growth variations of salmonids, based on age and body size of adult salmonids returning to spawning rivers and biological data of salmonids collected by research vessels in the North Pacific Ocean. Examine formation of hard tissues, such as otolith and scales, in order to clarify the growth mechanisms. Conduct experiments in order to clarify external (water temperature and feeding conditions) and internal (fish density) factors that cause growth variations of salmonids. Investigate the feeding ecology of salmonids in the North Pacific Ocean. Establish methods to assess the nutritional condition of salmonids. Identify mechanisms of variations in feeding ecology and nutritinal condition.

J-2 Population dynamics, mortality, carrying capacity, and ocean environment

This research addresses the following issues: Estimate the survival rates of salmonids from changes in salmonid abundance by age group and by year, based on data collected by research vessels. Investigate the occurrence of salmonids affected by diseases or predators, and distribution of predators. Investigate factors affecting the survival, such as predation, starvation, and diseases, by experimental methods. Establish methods to assess the carrying capacity of salmonid populations based on accumulated meteorological and oceanographic data (including plankton data) and biological data of salmonids, and examine the relationships between meteorological and oceanographic factors and salmonid carrying capacity. Investigate the salmonid ecology in winter using a large research vessel, clarify the southern limit of salmonid distribution in winter, examine the so called "reverse migration hypothesis" in that salmonids migrate northwards to minimize metabolic demands and maximize utilization of food in winter, and elucidate the relationship between wintering ecology and population dynamics of salmonids.

J-3 Stock assessment, biological monitoring, and stock identification

This research is undertaken to address the following issues: Develop methods for stock identification of salmonids including juveniles: (1) scale and otolith pattern analysis, (2) genetic analysis, and (3) artificial and biological tagging. Continue salmon research vessel surveys in summer, and establish methods to assess salmonid abundance and biological characters by species and stock. Establish methods of estimating abundance and survival of juvenile salmonids before wintering. Monitor genetic and reproductive characters, population structure of mature salmonids returning to their natal rivers. Improve biological monitoring methods for primary and secondary producers, competitors, and predators of salmonids in the North Pacific Ocean.

Russian Research Plan

R -1 Distribution, migration, growth, abundance, and mortality

In summer 1997-1998 the calculations of Pacific salmon abundance and observations on its distribution and migrations will be mainly conducted in the Sea of Okhotsk, and in Pacific Ocean off Kuril Islands. In fall 1997 the same investigations will be undertaken in the western Bering Sea and Pacific Ocean off Eastern Kamchatka. Middle-tonnaged vessels of STM-833 type equipped with pelagic trawl of 108/528 m will be used. The growth and natural mortality rates of pink, chum and sockeye salmon will be studied using the database for the period from 1984 till the present time. Research will be undertaken during May-October 1997 in the Russian EEZ. Ichthyological, hydrobiological, and oceanological data should be collected in order to examine feeding habits and migration patterns of local salmon stocks during their pre-spawning period. Fishing vessels equipped with driftnets and special scientific equipment will be used to get such information.

R -2 Stock identification

Stock identification will be conducted using genetic and scale characters. Basic data will be collected from the main sockeye, pink, and chum salmon populations, and from sampling of other salmon species.

Genetics. The research program will cover an expanded geographic range of native populations from the Kuril Islands, and Kamchatka River Basin will be added to the database to characterize genetic divergence of those species. An electrophoretic study of Asian chinook salmon will be initiated. Research on distribution of Pacific salmon in the ocean will be focused on stock identification of pink, chum, sockeye, and chinook salmon in mixed sample collections from the Bering Sea and Pacific Ocean in the area east of Northern Kuril Straits.

Scales. Investigations concerning scale sampling and processing techniques will be aimed at their standardization. This will help with correct analysis of growth characteristics. The sampling and processing of other materials (otoliths, data on parasites, etc.) are also included in the program.

R-3 Environmental impact

The main task of these investigations is to estimate quantitatively the influence of environmental factors (temperature, hydrological conditions) on salmon mortality during the embryo-larval stage, observations are being conducted in Western Kamchatka (the Utka River) and the Primorie region. The results will be used to improve the methods of forecasting salmon returns, and to project advantageous disposal of emerging salmon hatcheries in the Russian Far East.

The influence of environmental factors on the abundance dynamics of stocks of western and eastern Kamchatka pink and sockeye salmon of Ozernaya River origin will be estimated.

R -4 Feeding, food supply, and role of Pacific salmon in pelagic ecosystem of the Northwestern Pacific

Feeding of Pacific salmon will be studied during summer and fall expeditions in the Far Eastern Seas and North Pacific Ocean. Food supply of salmon will be assessed on base zooplankton samples collected at each trawl station using Juday's net at two depths (0-50 and 50-200 m) and micronekton catches (squids, forage fish) by pelagic trawl with small size mesh (10 mm) insert. A comparison between salmon and other pelagic fishes in the consumption of planktonic/ micronektonic organisms will help to estimate the place of salmon in the trophic structure of northwest Pacific pelagic ecosystems.

United States Research Plan

U-1 Coastal salmon studies

A long-term coastal monitoring program was begun in 1996 designed to provide repeated measurements of the habitat, and biological and population characteristics of salmon from their early marine residence period to their later migration through coastal waters. Particular focus is placed on monitoring thermally marked pink and chum salmon stocks and studying effects of climate forcing on the physical and biological characteristics of salmon habitat. Other coastal projects are directed towards: (1) understanding biological and physical factors that influence the spatial and temporal occurrence of juvenile salmon as they migrate seaward; (2) prediction of year-class strength and adult size of southeast Alaska pink salmon based on first-year scale and otolith growth; and (3) describing the trophic dynamics of juvenile salmon and their predators in coastal waters.

U-2 Gulf of Alaska salmon ecology

Research activities are primarily located in Alaska Coastal Current waters and include: (1) broad-scale field studies of the distribution and migration of juvenile and immature salmonids; (2) studies on diet overlap and prey selectivity among salmon and other fishes; (3) genetic studies on stock identification of juvenile, immature, and maturing salmon; (4) monitoring of thermally marked salmon; and (5) studies of growth and size of juvenile and immature salmon.

U-3 Retrospective studies

Retrospective studies characterize past variability in climate and salmonid population parameters over various time and space scales and are a key component to understanding effects of climate change on the abundance and life-history of U.S. salmon populations. Current retrospective studies include: (1) an analysis of scale growth patterns of Karluk lake sockeye salmon, and a summary of historical salmon research in the Karluk Lake area, (2) reconstructing long-term changes in salmon abundance using high-resolution paleoenvironmental analysis of sediment cores from sockeye salmon lake systems in North America and anoxic marine basins in Southeast Alaska, (3) analyses of pink and chum salmon growth patterns from geographically separated Alaskan populations, (4) use of bivalve and fish bone remains in Alaskan cultural deposits (middens) to reconstruct millennial changes in the environment as well as speciation and growth of fish and shellfish in coastal waters, (5) time-series analyses of catch, escapement, a growth data from North American salmonid and herring populations; and (6) resumption of historic population assessments of pink and chum salmon at Sashin Creek and Olsen Bay, Alaska.

U-4 Stock identification

This research program is designed to develop biological markers capable of identifying stocks of salmon in the North Pacific Ocean. These biological markers include genetic characters developed from protein electrophoresis and DNA, and non-genetic characters derived from scale pattern analysis and thermal marks on otoliths. The first task is to develop standardized methods of genetic analysis among parties, and to identify important stocks of salmon that should be included in the database. The United States is also continuing international cooperative high-seas tagging studies and recovery of coded-wire tagged salmonids in ocean fisheries and research vessel operations. These data will assist in identifying the origins of stocks harvested in mixed-stock fisheries, and in determining the oceanic distribution of stocks.

U-5 High-seas salmon studies

An integrated program of field and laboratory studies, and computer modeling in cooperation with the other Parties, is designed to address NPAFC-related scientific research issues in the international waters of the North Pacific Ocean and Bering Sea. The current cooperative program includes: (1) field research aboard salmon research vessels, (2) analyses of high-seas salmonid food habits data and development of ocean salmon bioenergetic models, (3) various studies ofocean growth of salmon using historical and recent high-seas salmonid scale collections and corresponding biological and oceanographic data, and (4) ocean salmon life history and carrying capacity modeling.

ISSN 1026-4159

Printed in Canada