NPAFC Science Plan 2006-2010

1. Broad Scientific Questions

Overarching hypotheses that emerged from the results of scientific research under previous NPAFC science plans, as well as from research by other organizations and independent scientists, are that (1) anadromous stocks play an important role in North Pacific marine ecosystems, and (2) there is a close relation between climate and climate change and subsequent changes in marine productivity and survival of anadromous stocks in the ocean. The Science Sub-Committee (SSC) identified two broad scientific questions relevant to the program goals of NPAFC that would further an ecosystem-based approach to conservation of North Pacific anadromous stocks, as well as contribute substantial new scientific information to the marine ecosystem research, fishery management, and conservation activities planned by relevant organizations:

- What are the current status and trends in marine production of anadromous stocks; and how are these trends related to population structure (spatial and temporal) and diversity of anadromous stocks in marine ecosystems of the North Pacific?
- How will climate and climate change affect anadromous stocks, ecologically related species, and their North Pacific marine ecosystems?

Over the past decade, there have been significant variations in the marine production of Asian and North American anadromous stocks that appear to be linked to climate change. There is a strong need for new international cooperative research that provides better scientific information on the status and trends in marine production of anadromous stocks, identifies the roles of anadromous stocks in North Pacific marine ecosystems, and examines the extent to which anadromous stocks, since they return to coastal regions, can be used as indicators of conditions in North Pacific marine ecosystems.

Variation in the time, frequency, and amplitude of climate events that affect the ocean production of marine fish seems to be increasing. This has led many experts to conclude that precision monitoring of abundance and biomass in the ocean may be the only reliable method for predicting changes in production of anadromous stocks. That each species of salmon follows a life history strategy in the ocean is probable. Cooperative research that identifies the common mechanisms will improve regional forecasting. In addition, the conceptual framework for the management of fish populations has expanded from relatively simple assessments of abundance and productivity to broader needs for information on population structure (spatial and temporal) and diversity.

2. Conceptual Model

The SSC used a salmon ecosystem/life history conceptual framework to render a holistic understanding of the two broad questions. Under this framework, Asian and North American anadromous stocks migrating in the Convention Area can be viewed as one large population that has evolved to respond successfully to natural stressors and stressor regimes at the ecosystem level. Salmon life history provides natural organization to this framework because at each maturity stage there is substantial regional and local variation in distribution and migration patterns, stressors, and stressor regimes that affect survival and growth rates. These differences may provide a buffer against climate variability and optimize the survival of the larger population. Cooperative research within this conceptual framework will provide information on abundance, biomass, vital rates, and processes essential to filling gaps in scientific information to evaluate effects of climate and climate changes in ocean ecosystems.

3. Research Theme: Status and Trends in Production of Anadromous Stocks in Ocean Ecosystems

The influence of regional and local environmental stressors on the status of different salmon species and stocks at initial and subsequent life history stages is varied. These stressors may affect the quantity and biomass of juvenile salmon migrating to the sea, immature and maturing salmon migrating in the open ocean, and adult salmon returning to coastal and freshwater fisheries. Obtaining reliable abundance estimates is essential to understanding survival at each marine life history stage. For conservation of anadromous stocks, better scientific information is needed on the effects of climate and climate change on anadromous stocks, ecologically related species, and their North Pacific marine ecosystems.

Cooperative research activities will attempt to clarify the present status and trends in production of North Pacific anadromous stocks, to determine important stressors and stressor regimes that affect population structure and diversity, to evaluate subsequent effects of these mechanisms on the viability and performance of North Pacific anadromous stocks at critical marine life-history stages, and to evaluate effects of climate and climate changes on marine production of anadromous stocks.

3.1 Component-1: Juvenile Anadromous Stocks in Ocean Ecosystems

In at least some species of anadromous stocks (e.g. pink and chum salmon), variation in adult returns may depend more on marine survival than on reproductive efficiency during the freshwater period. A common hypothesis is that the initial period of after migration to sea is the most critical phase with respect to ocean survival of anadromous stocks. Recent cooperative and national research on juvenile salmon suggests considerable interannual variation in abundance, growth, and survival rates of juvenile salmon in the ocean. These variations may be related to climate-induced changes in habitat environments that operate at regional and local scales. To a greater or lesser extent, these processes are monitored annually in marine survey areas along the coasts of Asia and North America. A better understanding of these processes is needed for conservation and management of anadromous stocks.

Cooperative research may focus on the following issues:

- Seasonal distribution and migration route/timing of juvenile salmon
- Hydrological characteristics, primary production, and prey resources in the habitats
- Trophic linkages, growth rates and predation rates of juvenile salmon
- Population size, survival rate and survival mechanism of juvenile salmon

3.2 Component 2: Anadromous Stocks in the Bering Sea Ecosystem

The centerpiece of NPAFC's marine ecosystem research to date is the Berign-Aleutian Salmon International Survey (BASIS). Under the Science Plan 2001-2005, BASIS research has progressed and evolved to more complex research issues, and has become an integral part of ecosystem research planned by other international, national, and regional conservation, management, and research organizations (e.g., PICES, North Pacific Research Board). In the face of global climate change, the Bering Sea may become the most important marine ecosystem for production of Asian and North American anadromous stocks. The results of cooperative BASIS ecosystem monitoring research in 2002-2004 indicated a very high density of Asian and North American anadromous stocks in the Bering Sea from summer to late fall. BASIS process studies have demonstrated the important influences that various physical and biological stressors and stressor regimes may have on production of anadromous stocks and ecologically related species in the Bering Sea ecosystem. While this recent research confirms the high productivity of the Bering Sea, carrying capacity, growth, and production of anadromous stocks has shown a high degree of variation. These results confirm the necessity of continuing cooperative research in the Bering Sea to clarify the mechanisms of biological response of anadromous stocks to climate and climate change.

Cooperative research may focus on the following critical issues:

- Distribution, migration route/timing, production, and health of anadromous stocks and ecologically related species
- Multi-year trends (regimes) in physical and biological factors that influence long-term changes in Bering Sea food production and fluctuations in salmon production and growth rates
- Hydrological characteristics, primary production, and prey resources in the habitats
- Trophic linkages, growth changes, and predation rate of anadromous stocks
- Interactions between species, between stocks, and between life-history stages
- Changes in carrying capacity of anadromous stocks

3.3 Component 3: Anadromous Stocks in the Western Subarctic Gyre and Gulf of Alaska Ecosystems

Anadromous stocks play a very important role in the Western Subarctic Gyre and Gulf of Alaska ecosystems. Immature and maturing salmon originating from Asia and North America intermingle in both of these ecosystems. Recent research vessel surveys by Canada, Japan, Russia, and the USA have collected a considerable amount of new data on anadromous stocks, ecologically related species, and environmental conditions in the Western Subarctic Gyre and Gulf of Alaska ecosystems. In particular, three species – pink, chum, and sockeye salmon – occur in high abundance in Western Subarctic Gyre and Gulf of Alaska ecosystems during all seasons. Anadromous stocks consume a substantial quantity and biomass of prey organisms in these ecosystems, and play an important role as a higher trophic level predator. Changes in marine tropic relations in these ecosystems influence the productivity of salmon populations returning to different reproduction regions in Asia and North America.

Both ecosystems provide the major wintering habitats for various anadromous stocks. While previous research has identified this as a critical period that defines the biological characteristics and biomass of anadromous stocks, open ocean field research and monitoring programs have typically been carried out only during the late spring to early fall period. Better information on the status and trends in production and condition of Pacific salmon during the late fall to early spring period is needed for conservation and management of salmon resources.

Knowledge of variation in the characteristics of marine production in the Western Subarctic Gyre and Gulf of Alaska ecosystems is needed for conservation of anadromous stocks resources in Asia and North America. In addition, more accurate forecasts of adult salmon returns will benefit salmon industries around the Pacific Rim.

Cooperative research may focus on the following issues:

- Seasonal distribution, production, and health of anadromous stocks and ecologically related species
- Seasonal changes in feeding, growth, and habitat condition
- Winter survival strategies of anadromous stocks
- Effects of climate change on population size and survival rate
- Multi-year trends (regimes) in physical and biological factors that influence long-term changes in food production and fluctuations in salmon production and growth rates
- Interactions between species, between stocks, and between life-history stages
- Changes in carrying capacity of anadromous stocks

3.4 Cooperative Research Approaches and Implementation of Science Plan

Relevant approaches to cooperative research under the Science Plan 2006-2010 will include collection and synthesis of existing data and metadata to generate and test specific hypotheses, integrated ecological monitoring research (research vessels, remote sensing), conceptual and quantitative modeling, process-

oriented field and laboratory studies, and retrospective analyses. Scientific results from cooperative studies using these approaches will progressively fill in major gaps in scientific knowledge with respect to the two research themes, components, and issues (sections 3.3), as well as contribute new scientific information to climate-change/ecosystem research being carried out by other relevant programs (e.g., PICES, North Pacific Research Board). NPAFC workshops and symposia serve an important purpose in the rapid exchange of significant new research results. The timely publication by NPAFC of research results presented at workshops and symposia is an important part of this process.

As in the case of the 2001-2006 BASIS research plan, specific proposals and approaches for new cooperative research under the NPAFC Science Plan will be developed at the CSRS working-group level, and will be subject to approval by the CSRS and the Commission. Implementation of cooperative research plans approved by the CSRS and the Commission under the Science Plan 2006-2010 will follow the same procedures that were approved by CSRS for the BASIS research program (Figure).

Specific policies for cooperation, identifying and addressing user needs, data quality, management and dissemination, logistics, outreach and education, and public involvement will be developed at the working-group or sub-group level, and will be subject to approval by the CSRS and the Commission.

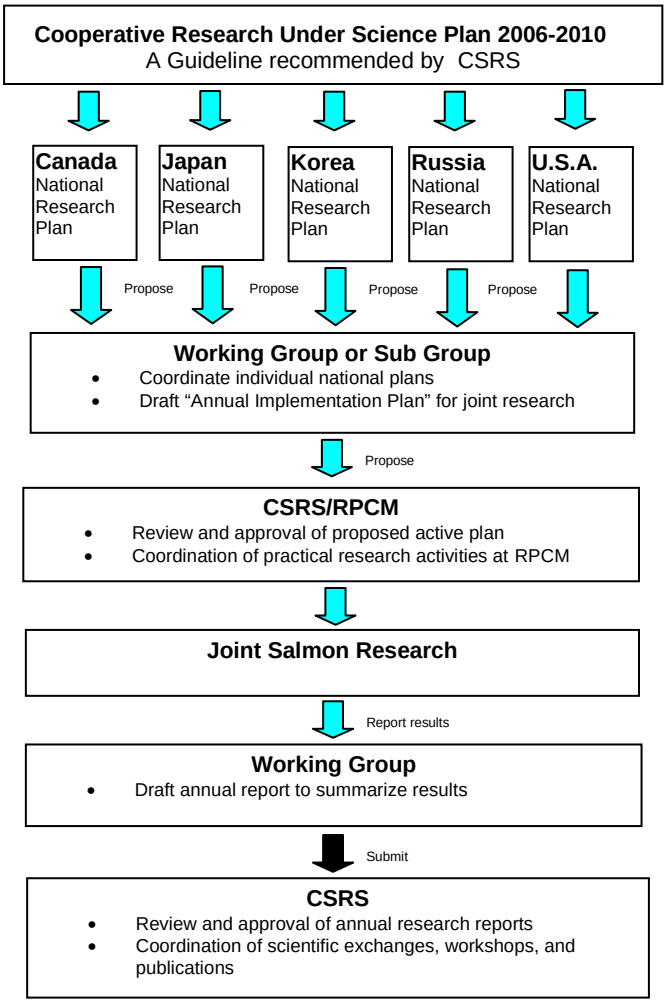

Figure Diagram showing the CSRS-approved guideline for implementation of cooperative research under the Science Plan 2006-2010.