AN ABSTRACT OF THE THESIS OF

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Julia Allen Jones

Salmon management philosophies of the five salmon jurisdictions of the North Pacific (Japan, Russia, Canada, Alaska and the American Northwest) are examined in a historical and geographic context. The first objective is to provide a synthesis of salmon management experience across the North Pacific, to serve as a context for the professionals and private citizens involved in day-to-day salmon management. The second objective is to elucidate the relative role of geography versus deliberate management action in shaping contemporary salmon management philosophies, on the basis of salmon management experience. Harvest trends, species composition, regulatory actions, property rights, technological innovation, climate variability, habitat alteration, markets, international agreements, and science are reviewed for each jurisdiction over time. The source material is drawn from a variety of scholarly and popular published sources, in Russian and English. The inferred salmon management philosophies of the five jurisdictions vary in their emphasis on three primary salmon management objectives: maximizing biomass production, preserving salmon harvest communities, and conserving salmonid genetic and life history diversity. All initially heavily emphasized biomass production, except for Canada. Only Japan, and Alaska after statehood, have given moderate or great emphasis to community preservation. Among the five jurisdictions, the only two to emphasize biodiversity conservation are the Pacific Northwest United States and British Columbia, Canada. The initial species

endowment of each jurisdiction, the landscape, climate variability and the cultural heritage of the dominant salmon harvesters are more critical at shaping salmon management philosophies than are incremental regulatory decisions over time. For instance, Japan's salmon ranching philosophy accrued from the availability of species without freshwater life history stages and the need to support a large human population. Favorable climate conditions in the 1970s facilitated the Japanese emphasis on hatchery chums and an engineering approach to contend with flooding and the demand for energy and water supplies. Change in salmon management philosophies, such as the shift to an emphasis on biodiversity conservation in British Columbia and the Pacific Northwest, occurs when the legal harvest rights of salmon harvester subgroups changes during a period of harvest decline. In the case of the latter two jurisdictions, the increased legal rights of native peoples have catalyzed a shift from an emphasis on biomass production to biodiversity conservation.

An Environmental History of the Salmon Management Philosophies of the North Pacific: Japan, Russia, Canada, Alaska and the Pacific Northwest United States

by

Xanthippe Augerot

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APPROVED:

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Major Professor, representing Geography

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Chair of Department of Geosciences

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Dean of Graduate School

I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

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Xanthippe Augerot, Author

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LIST OF ABBREVIATIONS

ACOE	Army Corps of Engineers
ADFG	Alaska Department of Fish and Game
ALPI	Aleutian Low Pressure Index
ANCSA	Alaska Native Claims Settlement Act
ANILCA	Alaska National Interest Lands Conservation Act
BPA	Bonneville Power Association
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
DFO	Department of Fisheries and Oceans
EEZ	Exclusive Economic Zone
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FAO	Fisheries and Agricultural Organization
FER	Far East Republic
FCA	Fisheries Cooperative Association
FEMAT	Forest Ecosystem Management Assessment Team
FWS	Fish and Wildlife Service
GATT	General Agreement on Tariffs and Trade
Glavryba	Soviet Central Fisheries Management Agency
HBC	Hudson's Bay Company
IUCN	International Union for the Conservation of Nature
LCRFDP	Lower Columbia River Fisheries Development Plan
MELP	Ministry of Land, Environment and Parks
MFCMA	Magnuson Fishery Conservation and Management Act
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration

LIST OF ABBREVIATIONS, Continued

NPAFC	North Pacific Anadromous Fish Commission
NPFMC	North Pacific Fishery Management Council
NPPC	Northwest Power Planning Council
PFMC	Pacific Fishery Management Council
PICES	North Pacific Marine Science Organization
PST	Pacific Salmon Treaty
RAC	Russian-American Company
RFE	Russian Far East
Rybvod	A territorial unit of the Federal Fisheries Conservation, Enhancement and Enforcement Agency, or Glavrybvod
SARC	Sea Area Regulatory Commission
TINRO	Pacific Fisheries and Oceanographic Research Institute
TTNRU	Territory of Traditional Natural Resource Use
UFAWU	United Fishermen and Allied Workers Union
UNCLOS	United Nations Convention on the Law of the Sea
USSR	Union of Soviet Socialist Republics
VNIRO	All-Russian Fisheries and Oceanographic Research Institute

AN ENVIRONMENTAL HISTORY OF THE SALMON MANAGEMENT PHILOSOPHIES OF THE NORTH PACIFIC: JAPAN, RUSSIA, CANADA, ALASKA AND THE AMERICAN NORTHWEST

CHAPTER 1 INTRODUCTION

The goal of this study is to provide a historical and biogeographic synthesis of the evolution of the salmon fisheries around the North Pacific from the mid 1800s to the present. Such a synthesis may help the professionals and private citizens involved in day-to-day salmon management to view their actions in a broader management context. The study area is determined by the range of commercially harvested anadromous *Oncorhynchus* species (the North Pacific salmon ecoregion), and the major salmon fishing countries within it (Figure 1.1). Anadromous *Oncorhynchus mykiss*, or steelhead trout, was included in the study, because it was harvested commercially at some time in each jurisdiction. Cutthroat trout *Oncorhynchus clarki* was omitted from this study. Approximately 90% of total North Pacific salmon harvests are composed of pink, chum and sockeye salmon (Figure 1.2; Beamish, 1993, 1102).

Five political jurisdictions were distinguished within the larger study area: Japan, Russia, Alaska, Canada, and American Northwest (Washington, Oregon, California and Idaho). These five jurisdictions comprise the entire range of the seven *Oncorhynchus* spp. (Figure 1.1), except for North and South Korea, which were excluded due to the lack of parallel information. Alaska and the American Northwest were treated as two units, because Alaskan salmon fisheries were managed directly by the federal government from 1867-1959, whereas the salmon fisheries in the contiguous United States were managed primarily by the states until the 1970s. Salmon management philosophies and harvest trends were similar in Washington, Oregon and California, so the states were treated as a unit. Idaho is

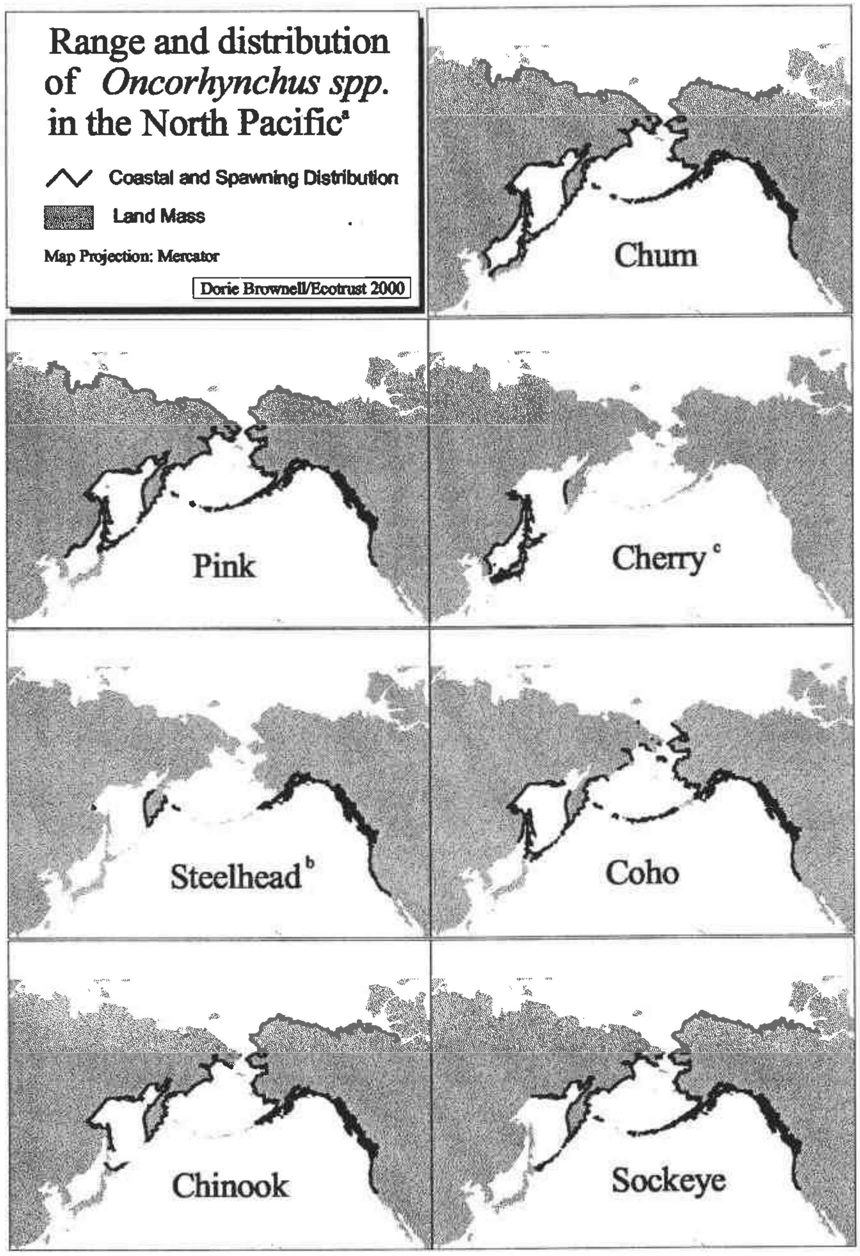

Figure 1.1. Range and distribution of *Oncorhynchus spp.* in the North Pacific. Steelhead range includes the distribution of resident *O. mykiss* as well as the anadromous form. Compiled by: Jeff Rodgers, for the Pacific Rim Project. Source: Groot and Margolis (1991), Russian fisheries scientists.

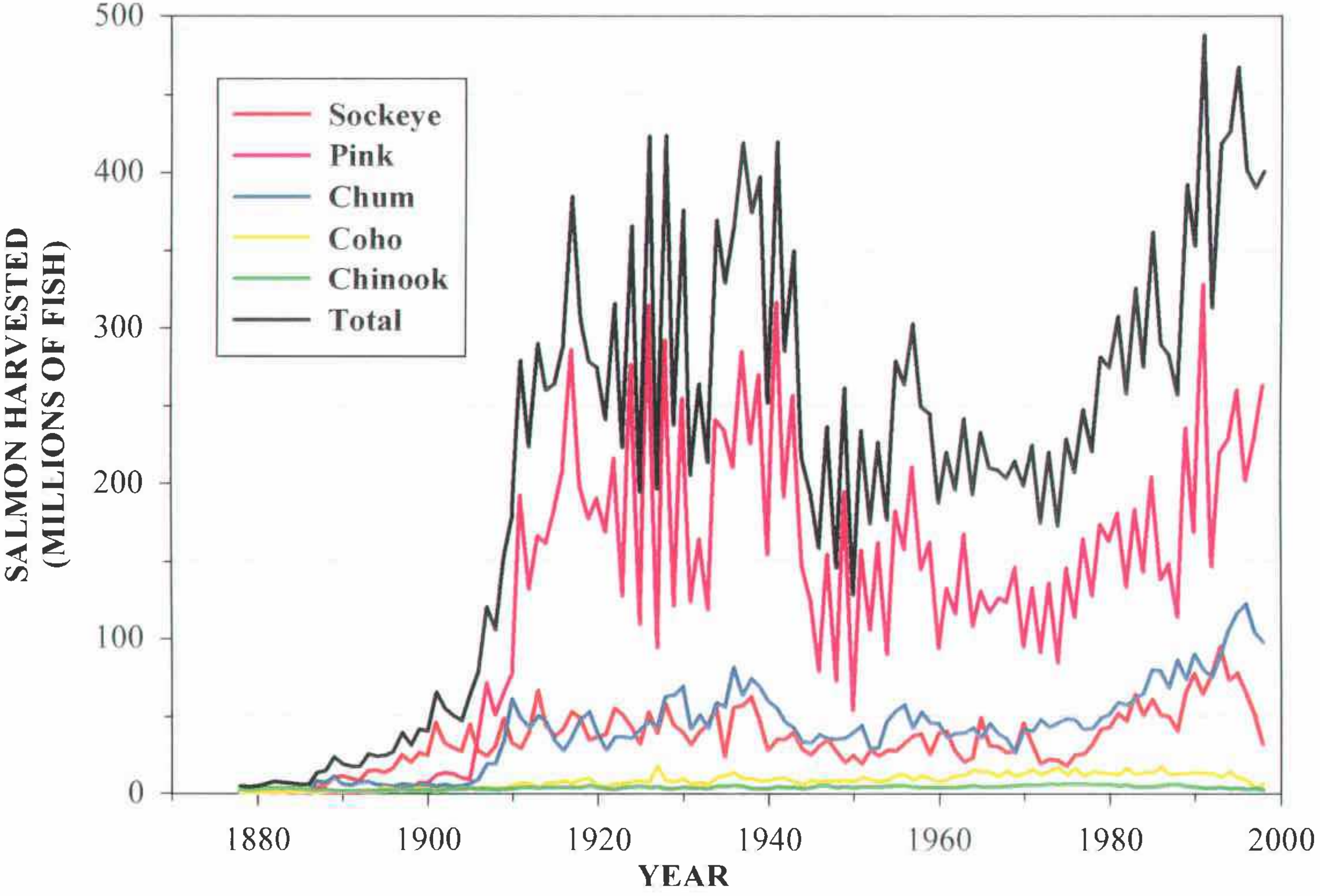

Figure 1.2. North Pacific salmon harvest, 1878-1998, by species in millions of fish. Sources: Hare et al. (1999), Shepard et al. (1985a), Ianovskaia et al. (1989), Rogers (1999). See Appendix for harvest data.

included in the Pacific Northwest states grouping despite the absence of a commercial fishery, because it represents a large proportion of Columbia River basin salmon habitat. For the sake of convenience, the jurisdiction of Russia is referred to as such throughout the introduction, summary and conclusions, and as the Union of Soviet Socialist Republics (USSR, or Soviet Union) only when relevant in the historical narratives. From the standpoint of salmon production and harvests, the relevant region is the Russian Far East. The jurisdiction of Canada is referred to as British Columbia, because it excludes the Upper Yukon River. The Upper Yukon River is a low-volume, primarily subsistence fishery, and has been managed very differently from the British Columbia fishery. The jurisdiction is referred to as Canada in discussions of policies or actions of the federal government, which has had jurisdiction over Pacific salmon since the fisheries began. The federal government has traditionally set salmon policy.

The objective of this study is to explain the variation in emphasis in salmon management philosophies over time and across the North Pacific salmonid ecosystem, on the basis of the historical trajectory of salmon management and the current configuration of the salmon fisheries in each jurisdiction. As used in this dissertation, the term "salmon management philosophy" includes management of salmon harvests, salmon habitat, and the salmon fishing community. The prevailing philosophy in each jurisdiction can be evaluated according to its emphasis on (1) biomass production, (2) biodiversity conservation, and (3) fishing community preservation. Biomass production refers to an emphasis on maximizing landings, whether through the absence of harvest regulations, hatchery production, distant-water fisheries or an emphasis on optimizing wild salmon escapement. Biodiversity conservation refers to an emphasis on long-term perpetuation of locally adapted viable populations of Pacific salmon and steelhead, preserving species, life history, and genetic diversity. Fishing community preservation refers to policies to perpetuate human communities composed of salmon harvesters.

This dissertation attempts to illustrate the following comparative trends in salmon management philosophy on the basis of historical narrative describing the evolution of the salmon fishery in each jurisdiction. The term "salmon fishery" encompasses harvesters, processors, managers, other members of society, salmon species, and climate (Figure 1.3).

(1) a strong historical concern for biomass production in all five jurisdictions, which has diminished recently in the American Northwest and British Columbia;

(2) increased concern for biodiversity conservation beginning in the late 1980s and early 1990s in the United States and British Columbia, less so in Alaska, and much less expressed in Japan and Russia, and

(3) a strong and sustained historical emphasis upon the preservation of salmon fishing communities in Japan, a moderate and variable level of concern in British Columbia, Russia and Alaska, and a modest emphasis in the American Northwest since the late 1970s.

This study evaluates the historical development of the salmon fisheries in the five jurisdictions, by addressing how salmon management philosophies have interacted with:

Harvest trends and salmon management history (Chapter 3)

Climate variability (Chapter 4)

Species composition and habitat alteration (Chapter 5)

Property rights (Chapter 6)

Changing technology (Chapter 7)

International relations among Canada, US, Japan and Russia (Chapter 8)

Markets (Chapter 9)

Science and Activism (Chapter 10)

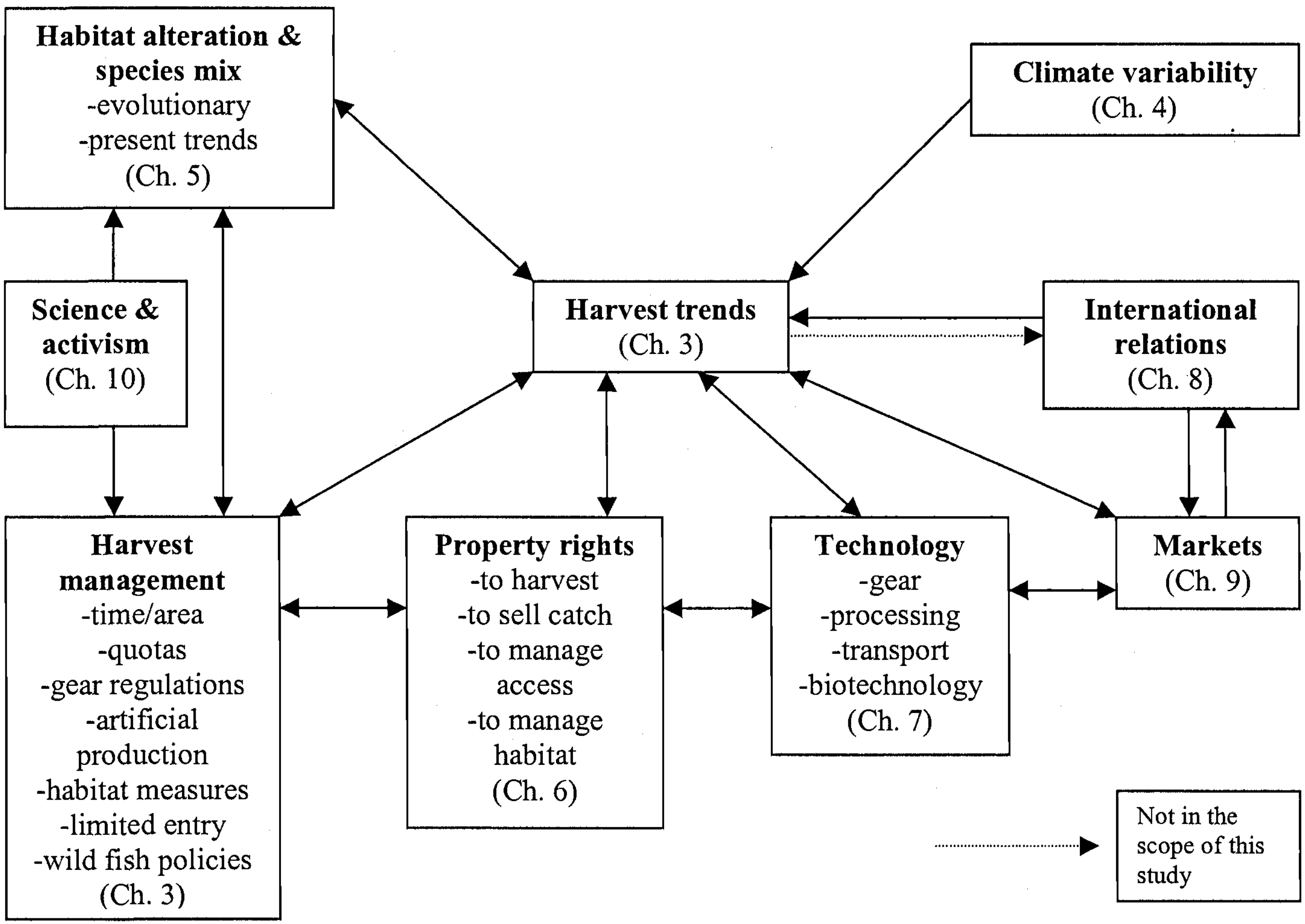

Figure 1.3. The salmon fishery system and structure of this study.

CHAPTER 2 METHODS AND BIBLIOGRAPHIC ESSAY

2.1 Introduction

Attempting to grasp the history of the salmon fisheries in all of the salmon countries of the North Pacific is a challenging task, particularly when one is reliant on only two of the three major languages spoken in the region (Russian and English). Ongoing professional relationships with fisheries biologists and managers in Russia, Canada, Japan and the United States through an array of projects at Oregon State University and the Wild Salmon Center have made the task worth trying.

This dissertation evolved from a project titled "Conservation strategies for salmonids of the Pacific Northwest: an ecosystem context for environmental and social systems of the North Pacific rim and ocean basin." The project came to be known simply as the "Pacific Rim Project." In addition to serving as the liaison with Russian collaborators, I was responsible for the development of a comparative historical narrative regarding the salmon fisheries of the North Pacific. The original intent of my analysis was to conduct a detailed comparison between the salmon fisheries in the Amur and the Columbia river basins and a broad sketch of national approaches to salmon management in the North Pacific. Over time, it became apparent that the basin-scale task depended greatly on the North Pacific narrative, and that the latter alone was a huge undertaking.

The Pacific Rim Project (Principal Investigator Michael Unsworth, Center for the Analysis of Environmental Change (CAEC)), was funded by the Environmental Protection Agency at Oregon State University. The goal of the project was to design a conservation strategy for Pacific Northwest salmon throughout its natural range or, in other words, in the context of the North Pacific "salmon ecosystem." The core objective of the project was the depiction of Pacific salmon and steelhead distribution in the context of key biophysical and anthropogenic attributes of the region, using Geographic Information System (GIS) technology.

The project team included Dan Bottom and Jeff Rodgers from the Oregon Department of Fish and Wildlife, Stan Gregory from the Fisheries and Wildlife Department at Oregon State University, and students Cathy Dey and Cathy Baldwin. A great deal of material was gathered regarding the biology of Pacific salmon and steelhead, their freshwater and ocean distribution, and biophysical habitat characteristics. The map-based material was integrated into a Geographic Information System by Jeff Rodgers and his student assistants.

The project did not reach closure before the funds ran out in 1997, and the principal staff returned full-time to their ODFW assignments. The project was picked up by the Wild Salmon Center (Portland, Oregon), which in the summer of 1999 began to compile the remaining species distribution and stock status data, as well as other supplementary data for the Russian Far East, Japan and Alaska. We developed new collaborative relationships with Russian and Canadian biologists, and a colleague in Japan. I am the coordinator for the Wild Salmon Center project.

I have drawn extensively upon the peer-reviewed and grey literature assembled for the project, particularly with regard to harvest data. Dorie Brownell has drawn upon GIS coverages assembled for the project to compose many of the maps and figures for the dissertation.

The Bikin River Demonstration Project (Principal Investigator Michael Unsworth, CAEC, OSU) funded two trips to the Russian Far East. My role in the Bikin Project was to coordinate a multidisciplinary team of Russian researchers in a demonstration watershed analysis. The travel afforded by my participation in the project provided me with the opportunity to collect materials and interviews used in the Russian narrative in this dissertation.

This dissertation involved reading and synthesis of literature across a broad range of disciplines. The remainder of this chapter describes the major sources used for various portions of the dissertation. Sources of information are arranged in the following order:

- Salmon in the North Pacific Ocean Basin
- Salmon harvest data
- Historical narratives on salmon fisheries, by country

2.2 Salmon in the North Pacific Ocean Basin

There are few texts that address the entire range of North Pacific salmon. The most notable is *Pacific Salmon Life Histories*, edited by Groot and Margolis (1991). The authors treat the Pacific salmon species by species, describing their life histories throughout their range. Prior to the Pacific Rim Project, Groot and Margolis represented the best available information on Pacific salmon distribution around the North Pacific. The flow of spatial and ecological information about Pacific salmon from Asia to North America has been poor, because of language, cultural, and political barriers. Present depictions of species distribution are in some cases inaccurate, and in most cases incomplete. Comprehensive information about life history patterns from the Western Pacific is absent, except as presented in drainage-specific research articles. The Japanese literature in English translation focuses largely on hatchery-related issues.

The other major work about the North Pacific and its resources, including salmon, is an atlas and companion reference entitled *The Management of Marine Regions: the North Pacific* (1982), edited by Edward Miles and others from the University of Washington's School of Marine Affairs. These two volumes are invaluable references regarding the regulatory agencies and legal frameworks for salmon in the North Pacific prior to 1982.

2.2.1 International Organizations

The International North Pacific Fisheries Commission (INPFC) created by the Tripartite Convention (1952) was replaced by the North Pacific Anadromous Fisheries Commission (NPAFC) in 1992. The latter Convention counts the Russian Federation as a member in addition to the original members of the INPFC (Japan, Canada, the United States). The NPAFC generates the official harvest record for the region, as did its predecessor the INPFC. The NPAFC staff also produce informative newsletters and bulletins. The NPAFC has a website at http:\\www.npafc.org.

The other new organization in the North Pacific is "PICES", the Pacific counterpart to the Atlantic-focused International Council for the Exploration of the Seas (ICES). Created in 1990 by the Convention on North Pacific Marine Science, PICES members include the major salmon countries participating in the NPAFC, plus the Peoples Republic of China and the Republic of Korea. The mission of the organization is to facilitate and coordinate ecosystem-based research regarding the ocean, atmosphere and living resources of the North Pacific. PICES is the principal coordinator for scientific studies about the region. Its useful website (http:\\www.pices.org) provides links to the numerous academic, governmental, and non-profit organizations with activities in the North Pacific.

2.2.2 North Pacific Studies

The best overall volume regarding salmon as a resource and focus of biological study in the North Pacific is the NPAFC's Bulletin Number 1, *Assessment and Status of Pacific Rim Salmonid Stocks* (1998). The introductory chapters, written by authors from each of the salmon jurisdictions (except Alaska), provided a good overview of harvest trends in the fisheries, as well as a glimpse of varying national perspectives regarding salmon resources. Pearcy's *Ocean Ecology of North Pacific Salmonids* (1992) was useful for its clear explanations of biological and atmospheric processes and its North Pacific ecosystem vantage point on salmon issues in the Eastern Pacific. *Salmonid Ecosystems of the North Pacific* (1980), edited by McNeil and Himsworth, was the earliest attempt I am aware of to compile descriptions of the North Pacific salmon ecosystem. Fredin's contribution, "Trends in North Pacific Salmon Fisheries" (1980), was one of the first efforts to disentangle historical harvest data for the various jurisdictions of the North Pacific, given interception harvests along migration pathways.

The economic trade relations and, in some cases, the political boundaries relevant for the North Pacific salmon fisheries were established during the maritime fur trade. Gibson's *Otter Skins, Boston Ships and China Goods* (1992) was indispensable for the author's careful examination of the development of the fur trade and the implications for local peoples and institutions around the North Pacific. For instance, fur trade-related international relations and colonial disputes helped shape political boundaries (e.g., the US-Canadian borders) and dictated the location and significance of early settlements (e.g., Sitka and Fort Vancouver).

Two books were helpful in providing anthropological and contemporary views of the native peoples of the North Pacific salmon ecosystem. *Crossroads of the Continents*, edited by Fitzhugh and Crowell (1988), provided an anthropological context for native cultures in the entire region, except for the contiguous United States. *First Fish, First People: Salmon Tales of the North Pacific Rim*, edited by Roche and McHutchison (1998) provided a contemporary and much more personal view of native peoples' traditions, feelings and opinions about salmon.

The book which most influenced my views about fisheries-society interactions was McEvoy's *The Fisherman's Problem: Ecology and Law in the California Fisheries* (1986). Writing in the environmental history tradition, McEvoy places the California fisheries in the context of changing natural systems, human institutions and values.

2.3 Data on Salmon Harvests

2.3.1 Japan

Japanese harvest data are the most complex among all of the jurisdictions of the North Pacific, because Japanese fishers are the only ones that fished for salmon beyond their own waters. When referring to Japanese harvests, "coastal" refers to salmon caught in fisheries within Fishery Cooperative Association (FCA) traditional territories, "offshore" refers to salmon harvests outside FCA territories but within the present-day 200-mile Exclusive Economic Zone, and "distant-water" refers to fisheries conducted within the waters of other countries or, prior to 1992, on the high seas.

Harvest trend data for Japan (Figures 3.6, 3.7 and 3.9) were compiled using tabular data for the various Japanese fisheries from Shepard, Shepard and Argue, *Historic Statistics of Salmon Production Around the Pacific Rim* (1985a). The authors' aim was not simply to reconstruct historical harvests, but to discern the relative productivity of each jurisdiction by species. Thus historical harvest statistics from a variety of sources were displayed by fishery (time, gear, location, target species) to clarify the jurisdiction of origin for the salmon landed. The harvest data presented here are a synthesis across the various tables presented by Shepard and colleagues for each species and year from 1868-1982. The authors present harvest data both in millions of fish and metric tons. For the purposes of the dissertation, millions of fish was selected as the primary measurement unit, to be consistent with data from Hare et. al (1999) for the Eastern Pacific.

Shepard et al. (1985) provide data through harvest year 1982. Harvest data for 1983-1998 was obtained from (Rogers, 1999, Tables 6-10). Despite the availability of harvest data from the NPAFC Statistical Yearbooks for 1993-1995, Rogers' data are used for several reasons. First, his statistics are current through the 1998 fishing season, whereas the Statistical Yearbooks are current only through 1995. Second, Rogers separated out high seas and coastal harvests, facilitating better characterization of the Japanese salmon fishing industry and chum returns to Japanese hatcheries and rivers.

Third, from 1992 through 1998, Rogers included Japanese treaty harvests in the Russian EEZ in his tally of distant water harvests. That data is not available (or unspecified) in the Japanese data presented in the NPAFC Statistical Yearbooks. Yearbook data is incomplete for Japan and Russia because of ongoing territorial disputes over the Kurile Islands and the sensitivity of Russo-Japanese fisheries negotiations (Myers, 2000). Japanese commercial harvests within the Russian EEZ appear to average about 15,000 metric tons/year (or 10 million fish) since 1992, and consist primarily of pink and chum salmon (Knapp and Johnson, 1995, 24). Coho and chinook salmon harvested by Japanese drift gillnetters in the Russian EEZ usually amount to less than 50,000 fish, and thus appear as zero in my harvest data (Figure 3.7).

Coastal harvest data for pink salmon are somewhat misleading (Figure 3.6). The summary pink salmon figures traditionally include cherry salmon as well. The figures reflect landings, and not terminal harvests of returns to Japanese rivers. Rogers (1999, Table 6) states that the majority of the landings reflect interception fisheries for Russian-origin fish in the Japan Sea. These fisheries are not included in the "distant-water" component, as they are not Russian commercial quota sales, but special agreements to conduct "research fisheries" in the Japan Sea (Knapp and Johnson, 1995, 24).

2.3.2 Russia

The Russian harvest data series extends from 1900-1998 (Figure 3.12). Russian historical harvest statistics have long been a subject of guess-work and extrapolation. As recently as the mid-1980s, Shepard and colleagues (1985a) relied upon extrapolation from combined Russian and Japanese harvest data to evaluate Russian catches prior to 1939. The harvest was attributed to Russia or Japan based upon the proportion of harvest leases held by citizens of each country, and based upon harvest data by species available for selected years. Thanks to Dr. Richard Beamish (Canada Department of Fisheries and Oceans; DFO), the Pacific Rim Project acquired a copy of Ianovskaia and colleagues' *Ulovy tikhookeanskikh lososei / Harvests of Pacific salmon 1900-1986* (1989). Originally compiled as an internal Russian Fisheries Committee (Roskomrybolovstva) document by the Russian Fisheries and Oceanographic Research Institute (VNIRO), the slender volume contains harvest statistics by volumes, species and region for the Russian Far East. In addition to the Pacific salmon species and steelhead, it also includes char landings. From 1940 through 1970, summary data for each species was rounded to the nearest ten tons. Harvests are summarized in metric tons only. There is no text accompanying the data regarding how they were compiled or the associated level of confidence.

Ianovskaia's (1989) data are based on best available information compiled by a collective of regional experts and, according to Russian colleagues, may not be particularly accurate. For instance, Amur River harvest data depict a 1910 peak in summer chum harvests that is anomalously high, both relative to fall chum productivity and to any other harvest year (Figure 3.11). Novomodny suspects that the 1910 datum, if not all the data regarding the first decade of Amur chum harvests, are inaccurate (Novomodny, 1998). For pink salmon harvests only, Chigirinskii (1994) conducted a systematic historical review for the NPAFC, "Asiatic pink salmon: commercial catch in the current century." This work revises Ianovskaia's totals for pink harvest downward substantially, to eliminate double-counting of Japanese harvests in Russian waters. It is probable that the VNIRO authorship also included Japanese shore-based harvests of other species in Russian landings between 1907 and 1945 (Figure 3.10). Nonetheless, Ianovskaia's data are used in this study, as they are the best currently available outside of Russia.

Harvest data for 1987-1992 are based upon United Nations Fisheries and Agriculture Organization (FAO) statistics compiled by the Alaska Center for International Business and reported by Knapp and Johnson in *The Russian salmon industry*. Data for 1993-1995 are drawn from the NPAFC *Statistical Yearbook* for the corresponding year. Although the latter statistics are presented in numbers of fish as well as metric tons, Russian harvest trends are presented in metric tons to avoid potentially erroneous back-calculation for previous years. Note, however, that Russian harvests were converted to millions of fish to derive Figures 1.2 and 3.1, depicting salmon harvest trends by species and by jurisdiction across the North Pacific. The Russian harvest data was converted to millions of fish using average weights by species from the 1995 NPAFC Statistical Yearbook, and thus may misrepresent harvests of a particular species within any given harvest year.

The NPAFC *Statistical Yearbooks* also present harvest data regarding Russian subsistence and "sport" fisheries between 1993-1995. Given the short time series available, these data were not presented graphically or combined with commercial harvest data. On the basis of the 1993-95 data, these two fisheries together typically equal approximately 5% of the commercial harvest. Russian "sport" fisheries are in fact individual consumptive fisheries, and in some areas a large proportion of the legal quota and illegal overharvest is sold commercially. Sport and subsistence harvest ratios also vary by species and geographic region. The "sport" fishery takes a much larger proportion of the total salmon harvest in heavily populated areas such as the Amur River basin in Khabarovsk Territory and the Avacha River basin on Kamchatka.

Given the high level of illegal harvests and underreporting in the Russian salmon fisheries, Russian harvest statistics are likely the least reliable among the five jurisdictions. Nonetheless, these data are the official "record" of salmon harvests, and the principal input to harvest management decision-making at the federal level.

2.3.3 British Columbia

Canadian harvest data span the period from 1878-1998 (Figure 3.16). Canadian harvest data for 1925-1998 were developed by Dr. Steven Hare for the co-authored article "Inverse Production Regimes: Alaska and West Coast Pacific Salmon"(1999). Hare's data set is based upon the International North Pacific Fisheries Commission (INPFC) Bulletin 39, "Historical Catch Statistics for Salmon of the North Pacific, 1925-1976." Data for later years were based upon subsequent INPFC and NPAFC Statistical Yearbooks through 1995. Commercial harvest data for 1996-1998 were obtained from *Pacific Fishing* magazine's "Statspack" issue, published in March of each year. Recreational harvest data for Canada were obtained by Hare from a colleague at Canada's Department of Fisheries and Oceans. I have extended Hare's data back to 1878, using data compiled by Shepard, Shepard and Argue (1985) in "Historic Statistics of Salmon Production around the North Pacific."

Data for British Columbia include estimated subsistence and sport harvests from 1925-1951, and actual harvest statistics where available thereafter. Although sport harvests vary in significance regionally, and were generally not substantial until the 1950s (i.e., at least 10% of the commercial catch), harvest trends for recent years would be inaccurate without their inclusion. For years prior to the routine collection of recreational and subsistence harvest data, Hare adjusted calculated harvests using empirically derived coefficients based upon the ratio of recreational-commercial and subsistence-commercial harvests.

As in Alaska and the American Northwest, early harvest data is based upon a conversion from canned salmon production statistics. The early harvest data likely underrepresent actual landings, because harvest capacity frequently overwhelmed processing capacity, leading to substantial volumes of unprocessed salmon in years of high abundance, prior to the availability of cold storage. The early data also omit chum, coho and chinook harvests, which were commonly salted, smoked or sold fresh (Healey, 1993, 248).

2.3.4 Alaska

The Alaskan harvest data series extends from 1878-1998 (Figure 3.18). Data from 1925-1998 were developed by Dr. Steven Hare for the co-authored article "Inverse Production Regimes: Alaska and West Coast Pacific Salmon"(1999). Hare's data set is based upon the International North Pacific Fisheries Commission (INPFC) Bulletin 39, "Historical Catch Statistics for Salmon of the North Pacific, 1925-1976." Data for later years were based upon subsequent INPFC and NPAFC Statistical Yearbooks through 1995 and *Pacific Fishing* magazine's March "Statspack" issue, for 1996-1998. I have extended Hare's data back to 1878 using Byerly et al. (1999) "Alaska Commercial Salmon Catches, 1878-1997."

As for British Columbia, the basic commercial landings data set was modified by Hare from 1924-1998, to reflect recreational and subsistence harvests. Empirically derived coefficients related recreational and subsistence harvests to commercial harvests by species and region over time. Recreational harvests varied regionally in significance and were generally not substantial until the 1950s (i.e., at least 10% of the commercial catch). However, harvest trends for recent years would be inaccurate without their inclusion.

2.3.5 American Northwest

Harvest trends for Washington, Oregon and California are presented for the period 1867-1998 (Figure 3.21). Dr. Steven Hare's data was used for the period from 1925-1998, modified to include recreational and tribal harvests. I extended Hare et al.'s data back in time to 1867, on the basis of harvest statistics from Shepard, Shepard and Argue (1985). As in British Columbia, pre-WWI harvests likely represent minimum harvest levels rather than actual harvests due to extrapolation from canned salmon pack statistics.

Several other points deserve comment with regard to the American Northwest statistics. First, Idaho reported small commercial salmon landings as late as the 1930s, and recreational and tribal harvests continue through the present, particularly for steelhead. These landings are not reflected in the data for this jurisdiction. Second, Hare chose to omit minor chum salmon landings by Oregon harvesters in the Columbia River basin from his data. Lastly, representation in millions of fish understates the volume of salmon harvested in the American Northwest because of the preponderance of chinook in the catch, with a much larger average weight than any of the other Pacific salmon species (Figure 2.1). The data in Figure 2.1 are not fully comparable to Hare's data, because I used Joint Columbia River Management Staff (1994) data, which do not include tribal and recreational harvests.

Columbia River harvest trends (Figure 3.20) are derived from the Joint Columbia River Management Staff (1994) Columbia River Fish Runs and Fisheries, 1938-1993. The original time series, extending from 1866-1993 is retained, and presented here in metric tons for comparability with the Amur River harvest time series (Figure 3.11). Prior to the 1920s, harvest data was based on salmon pack, and the same precautions apply as for the British Columbia and the Pacific Northwest time series.

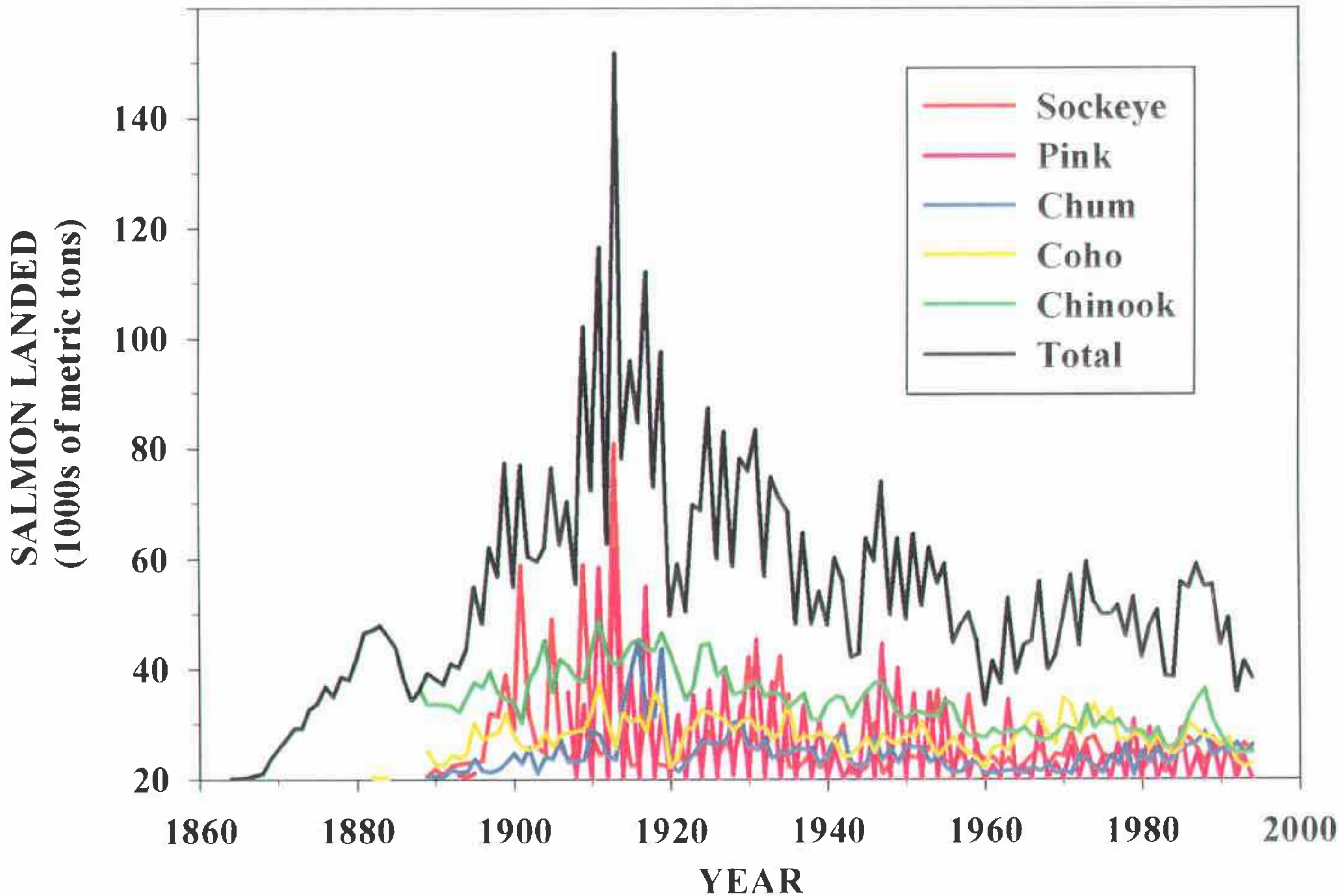

Figure 2.1. American Northwest salmon harvests, 1867-1998, in thousands of metric tons. Includes Washington, Oregon, and California, harvests, omits Idaho. Harvests after 1924 are adjusted to include recreational and native catch. Sources: Hare et al. (1999), Shepard et al. (1985).

2.4 Sources for Salmon Fisheries Historical Narratives

The sources used on a jurisdiction by jurisdiction basis were numerous and varied. The range of sources used for each jurisdictional narrative are described below, emphasizing those that were most important in shaping my view and interpretation of events relating to the salmon fisheries, the sociopolitical context, and the environment of each region.

2.4.1 Japan

There is no comprehensive history of Japanese salmon fisheries published in English. The only existing chronology utilized came from the Japan Fisheries Association website (http://www.suisankai.or.ip/index_e.html). The Japanese narrative is, therefore, the least detailed.

Proceedings published by the National Federation of Fisheries Cooperative Associations (Zengyoren), entitled *International Perspectives on Fisheries Management with Special Emphasis on Community-based Management Systems Developed in Japan* (1991) were very important in framing the Japanese narrative. The papers introduced me to the basic fisheries management system in Japan, but raised as many questions as they answered. The Japanese authors were not explicit about the sociopolitical context for the development of the fishery management system, nor did they include many spatial references to actual fishing locations. The only article focused on salmon was Matsuda's "Marine Ranching in Japan – from Salmon to Red Sea Bream."

The most useful articles regarding Japanese fisheries management were from a collection entitled *A Sea of Small Boats*, edited by John Cordell (1989). Contributions by Ruddle and Akimichi, Short, and Wigen put Japanese fisheries management in a larger historical and cultural context.

Dr. Kaeriyama's articles "Aspects of Salmon Ranching in Japan" and "Hatchery Programmes and Stock Management of Salmonid Populations in Japan" were the most useful references regarding salmon production and management in

Japan (1989; 1999a). Hayashi's "Fisheries in the North Pacific: Japan at a Turning Point" (1991) provided an excellent overview of international salmon allocation issues, from Japan's perspective.

The most enlightening source regarding Japanese fisheries was a book-length work by political scientist David Howell, *Capitalism from Within* (1995). Howell's thesis is that Tokugawa-era Japanese fisheries had all of the necessary elements in place to flourish in the capitalist Meiji era. The constituents of a capitalist fishery were not introduced after the Meiji Restoration – rather the legal system caught up with events in the fishery. Although Howell's book focuses solely on the herring fisheries of Hokkaido, there are strong parallels with the development of the salmon fishery. Both depended upon the opening of Ezochi (Hokkaido) by the Matsumae domain and the development of contract fisheries. The principal and secondary fishing gears, the net trap and the gillnet, were also the same. Citation of Howell's work assumes that the patterns of geographic, economic and political development were very similar in the salmon and herring fisheries. My assumption is based upon Howell's statement that the same people were involved in the herring fishery in the spring, the trout (cherry salmon) fishery in the summer, and the salmon fishery in the fall.

There is not a great deal published in English about Japan's native peoples. Siddle's "Ainu", in *Japan's Minorities*, edited by Weiner (1997) was the principal source. Father and son Shigeru and Shiro Kayano, in *First Fish, First People* (1998a; 1998b; Roche and McHutchison, 1998) provided personal and Ainu community perspectives with regard to salmon.

2.4.2 Russia

As with Japan, the first sources employed covered the broader sweep of Russian colonization, geography, native cultures and international diplomacy, to provide a basic context for the history of the fisheries. This was particularly essential in the Russian case, as the principal sources regarding Russian fisheries history were tightly focused on either salmon stocks or industry economics, rather than the larger societal context. A great deal of the background material regarding the physical environment, settlement history, and political history was drawn from a variety of Russian and English language sources, ranging from older monographs to the contemporary popular press.

Although not cited extensively, two monographs were extremely helpful in clarifying the history of Russian colonization of the Far East. They are Lincoln's *Conquest of a continent: Siberia and the Russians* (1994) and *Bobrick's East of the Sun: the epic conquest and tragic history of Siberia* (1992). Both trace Russian colonization of Siberia and the Far East through the Stalin era in the 1930s. Lincoln's monograph is the more scholarly and readable of the two, and became a frequent reference during the assembly of the Russian historical narrative.

The Bikin River Demonstration Project was my introduction to the Russian Far Eastern salmon fisheries. The Bikin is a tributary the Amur (Ussuri) River, in Primorsky Territory. The project produced a book, *Ekosistemy basseina reki Bikin: sreda, chelovek, upravlenie* / Ecosystems of the Bikin River basin: environment, people, management (Zolotukhin et al., 1997). The historical sections were authored by Sergey Zolotukhin, fisheries biologist and Vadim Turaev, ethnographer. Both utilized a combination of primary and secondary sources to describe the role of fisheries in pre- and post-Slavic colonization periods, trends in salmon abundance, and fisheries management. My questions during the course of the project shaped the historical content of the book, and provided a major bibliographic source for my dissertation.

While the Bikin research introduced me to the first Russian salmon fishery in the Russian Far East, the narrative still lacked a perspective on the geographic, economic and administrative development of fisheries across the region. Mandrik's *Istoriia rybnoi promyshlennosti rossiiskogo Dal'nego Vostoka* / History of the fishing industry of the Russian Far East (1994) helped to fill the void. Mandrik's work suffers several shortcomings, partly attributable to the fact that it was researched and written prior to the collapse of the Soviet Union. The work greatly minimizes the role of the Japanese in developing the Far Eastern fisheries, and emphasizes the accumulation of capital over evolution of the fisheries and their management. Nonetheless, careful repeated readings of Mandrik's work provided a sense for the geographic development of Russia's Far Eastern fisheries and the most comprehensive information available in the secondary literature with regard to pre-revolutionary fisheries management.

Two pieces by Sergey Vakhrin, timelines published in a collection of essays and a regional fisheries magazine, shed further light on the development of the salmon fisheries on the Kamchatka Peninsula, and the general geographic progression of the Far Eastern fisheries (Vakhrin, 1996b; Vakhrin, 1996a). Vakhrin is an amateur historian and journalist with Kamchatrybvod, the territorial unit of the federal fisheries management agency on Kamchatka. Vakhrin's writing does not contain references, thus sources are impossible to verify. Where Vakhrin's version of the history of the fisheries differed from Mandrik (1994) and Zolotukhin (1997) it was disregarded, unless the information was Kamchatka-specific.

In the post-Sputnik era, many Russian scientific publications were translated by a joint US-Israeli translation program, among them several fisheries articles. Two of these volumes were particularly useful, as they provided the core of my material regarding the evolution of Russian fisheries science. The first is Borisov's *Fisheries research in Russia: a historical survey* (1964). The second is a selection of fisheries articles from Soviet periodicals, entitled *Pacific salmon* (Israel Program for Scientific Translations, 1961). An article by Eniutina, "The Amur pink salmon (Oncorhynchus gorbuscha): a commercial and biological survey" (1974), was also published in English in the same period. The latter article corroborated and clarified many aspects of the Amur River fisheries.

There have been a handful of articles and reports written in English about the Russian salmon fisheries. They come from two very different eras, early 20th century and the mid-1990s. *Pacific Fisherman*'s "The salmon canning industry of Siberia" (1914) was written as WWI began to calm US industry fears, particularly in the Alaska fisheries, of a Russo-Japanese takeover of lucrative sockeye markets. Baievsky's "Fisheries of Siberia" (1926) was commissioned by the US Commissioner of Fisheries after the Russian Revolution, in the Commission's role to aid the US industry in identifying investment opportunities. Russia was in the midst of the Soviet "New Economic Policy", which encouraged foreign investment in natural resource extraction and heavy industry, in order to rebuild its war-ravaged economy. Baievsky provided a region by region description of the salmon fisheries of the Russian Far East, the resources, and the degree of fishery development. This piece helped to piece together the geographic pattern of Russian salmon fishery development, and clarified the Japanese role in Russian fisheries.

The series of reports and articles in the 1990s was generated by very similar motives. The first report to come out, GLOBEFISH's "The fishery industry in the Russian Far East" (1994), was an exploration of the investment potential in the Far Eastern fisheries in the aftermath of the Soviet Union's collapse. GLOBEFISH was a United Nations Food and Agricultural Organization study, financed by the fishing ministries of several western countries. The second series of reports arose because of renewed Alaskan concerns about potential competition from the Russian fishing industry. The first is a report commissioned by the State of Alaska, authored by Knapp and Johnson, "The Russian salmon industry: an initial review" (1995). The second was a study mandated by Congress, and compiled by the North Pacific Fishery Management Council entitled "Russian Far East fisheries management" (1997). The former report was particularly useful, as it provided the best explanations I have seen regarding the contemporary Russo-Japanese fisheries relationship. The latter report substantiated much of what I had read in the Russian fisheries and popular press, and learned from Russian colleagues.

Several newspapers and newsletters were very helpful. The *Russian Conservation News* (various issues) provided timely background regarding changes in Russian environmental law and regulations, as well as stories regarding habitat threats around the Russian Far East. Regional fisheries newspapers, such as "Rybak Primor'e" (Primorye Fisherman) and "Rybak Khabarovskogo kraia" (Khabarovsky Territory Fisherman) also provided insight into the contemporary Russian fishing industry. Lastly, Vakhrin's biannual publication "Severnaia patsifika" (North Pacific) served as a primary source or corroboration for information about the politics and management associated with the salmon fishery (http://np.rybvod.kamchatka.su).

With few exceptions, the fisheries literature provided little context in terms of governance structures or the larger geographical and political trends across the region. Stephan's *The Russian Far East: a history* (1994) filled that void in a timely and efficient manner. Stephan's work is the first comprehensive history of the Russian Far East in any language, and provides an invaluable portrayal of regional, national and international politics, which shaped the Russian Far East and descriptions of the evolving administrative structures. Stephan's synthesis of primary and secondary material published in Russia, Asia and the west provided most of the 20th century historical material for the dissertation regarding regional politics and the socio-economic milieu in the Russian Far East.

In his history of the fisheries, Mandrik states that the impasse between Russia and Japan with regard to rules governing fishing rights was a major cause of the Russo-Japanese War of 1904-5. A literature search regarding the Russo-Japanese War and the broader colonial history of Asia and the Russian Far East did not provide any corroboration for Mandrik's assertion, though it likely contains an element of truth. The best overall summary of Russia's colonial politics in Primorye and Priamurye, the Korean Peninsula and Manchuria (the Sino-Russian borderlands) is Malozemoff's "Russian Far Eastern policy 1881-1904" (1958).

2.4.3 British Columbia

As with the other countries, researching the history of the salmon fishery in British Columbia, Canada, was much like assembling a quilt. Certain texts serve as keys, which unlock the meaning of entire sequences of events. Often a subsequent reading would make an earlier article or book much more meaningful. There appears to be a threshold effect for immersion, beyond which one suddenly understands the relevance of previously arcane material.

That was certainly my experience with unraveling the British Columbia salmon fisheries. I began with two invaluable volumes, one authored and one edited jointly by

L. S. Parsons, *Management of Marine Fisheries in Canada* and *Perspectives on Canadian Fisheries Management* (1993; 1993). Although both volumes were filled with factual information and perspectives, it was still difficult to see the big picture.

With regard to British Columbia fisheries, there were two key resources. One was a collection of articles edited by Marchak and colleagues, entitled *Uncommon Property: the fishing and fish-processing industries in British Columbia* (1987). The second was Meggs' *Salmon: the Decline of the B. C. Fishery* (1991). Marchak and colleagues clarified the role of government salmon managers in free-market systems, to create and maintain regulations, which facilitate the accumulation of capital. As such, government salmon managers' conservation measures primarily considered the interests of salmon canners and processors. Meggs' monograph highlighted the role of harvester unionization in altering the relationship between salmon managers and processors. Given my United States' frame of reference, where economically meaningful harvesters' unions were declared in violation of anti-trust laws in the 1930s (Meggs 1991), the unions' vital role in Canadian fisheries development and management was not immediately apparent.

Two other monographs regarding the Canadian fisheries were very useful in assembling the British Columbia narrative. Newell's *Tangled Webs of History: Indians and the Law in Canada's Pacific Coast Fisheries* was helpful with regard to native harvest rights and regulatory change in general. Newell's chronology and description occasionally differed from Parsons' (1993), which prompted me to check and cross-check certain aspects of early British Columbia salmon management, particularly with regard to limited entry and the boat rating system. Lyons' *Salmon: Our Heritage* was an invaluable resource after the basic outline of the British Columbia narrative was in place. Her memoir of the salmon industry focuses extensively on the people who developed the fishery, and it was initially difficult to calibrate the relative importance of specific events, correspondence and transactions described. Lyons' book contains several useful appendices, including a list of federal fisheries investigations, excerpts from Federal Investigatory Commission reports, and a chronological list of federal ministries responsible for the fisheries portfolio over time.

The respective roles of the federal Department of Fisheries and Oceans and multiple natural resource agencies at the provincial level were quite confusing. Bill Otway, Pacific Division of the Department of Fisheries and Oceans, recommended that I peruse the agency web sites for more detailed information. His suggestion was invaluable, as the federal and provincial agencies involved with fisheries and environmental management have informative web sites (Pacific Division, Canadian Department of Fisheries and Oceans www.pac.dfo-mpo.gc.ca/; B. C. Fisheries www.fisheries.gov.bc.ca/; the British Columbia Ministry of Environment, Land and Park www.env.gov.bc.ca/; and Environment Canada www.ec.gc.ca/envhome.html).

2.4.4 Alaska

Perhaps because of the relative prosperity of the Alaskan salmon industry and stable salmon population trends over the past two decades, there is very little scholarly literature on the history of the Alaskan salmon fishery. The two principal sources were Cooley's *Politics and Conservation: the Decline of the Alaska Salmon* (1963) and Crutchfield and Pontecorvo's *The Pacific Salmon Fisheries: A Study of Irrational Conservation* (1969). Both were written when the Alaska salmon fisheries were in the midst of long-term depression, because of a combination of adverse marine survival conditions and overharvest, including Japanese interceptions of Alaskan-origin salmon on the high seas (Figure 3.15). The authors of these volumes argue for economic rationalization of the fisheries, perceived to be a solution to most salmon fishery problems at the time. In addition to an extensive discussion of the economics of the fishery, Cooley also devotes great attention to Congressional and Bureau of Fisheries politics regarding the Alaska fisheries.

Haycox and Mangusso's "Alaska history," provided general historical context in the introduction to their *Alaskan Anthology* (1996). Pennoyer's "Development of management of Alaska's salmon fisheries" (1978) provided a post-statehood chronology of fisheries management in Alaska.

The forementioned resources left me with many questions regarding salmon management in Alaska, particularly with regard to the hatchery system and limited entry. As for British Columbia, I was able to gather the information I needed through a combination of personal communications (e.g., Geiger, Muse and McGee) and web-site follow-up through the Alaska Department of Fish and Game (http://www.state.ak.us/adfg/adfghome.htm) and the Commercial Fisheries Entry Commission (http://www.cfec.state.ak.us/).

2.4.5 American Northwest

Synthesizing the historical narrative for the contiguous United States presented its own challenges. The primary and secondary literature are extensive, principally in regard to the history and present dilemmas of the Columbia River salmon fisheries. Secondary historical literature regarding the California and Washington fisheries is much sparser. Secondly, although I am treating the Pacific Northwest US as a single unit, it could easily be argued that this region should be analyzed by state, plus a narrative for the Columbia River basin. I have tried to glean the commonalities from the narratives regarding the major fisheries of the region: the San Joaquin-Sacramento, Klamath, Columbia River, Washington and Oregon Coasts, and Puget Sound.

Several sources describe the historical and present situation with regard to the salmon fisheries throughout the region. The Natural Research Council's *Upstream: salmon and society in the Pacific Northwest* (1996) provides the broadest overview of contemporary issues and a thumbnail history. The volume is full of interesting information, which was useful after a preliminary chronology was in place. Cone and Ridlington's *The Northwest Salmon Crisis* (1996) was extremely useful. Their collection includes many key documents regarding the Northwest salmon fisheries in one place, accompanied by helpful interpretive essays which highlighted the importance of particular historical events. Both the documents excerpted and the accompanying essays were helpful in the initial formulation of a regional chronology.

Despite its broad title, *The Northwest Salmon Crisis* focuses primarily on Columbia River events.

My principal source regarding the early history of the Columbia River salmon fisheries was Taylor's doctoral dissertation, "Making salmon: economy, culture, and science in the Oregon fisheries, precontact to 1960" (1998b). Taylor's thesis is that Oregon fisheries managers chose hatcheries, a technological solution, in preference to harvest regulation, which requires people management. He sees our current predicament as inevitable, given our capitalist system, and views the vast Pacific Northwest hatchery system as a co-optation of fisheries biologists. The state and federal fisheries bureaucracies vested individual biologists with self-interest in perpetuating their own organizations, and thus the overall technological approach.

Taylor's dissertation left many gaps in terms of specific changes in the regulatory framework for salmon management, and management beyond Oregon's borders. That gap was filled primarily by a series of papers prepared for the Pacific Northwest Regional Commission, collectively entitled "Investigative reports of the Columbia River Fisheries Project" (1976). It is the product of a Columbia River Working Group, which developed the papers as background for multiple use natural resource management planning for the Columbia Basin as part of the river basin-based land use planning movement in the 1960s and 1970s. Papers on decision-making systems and commercial fishing regulation provided details about the development and practice of fisheries management in Washington, Oregon and Idaho (Ortmann, 1976; Phinney, 1976). Articles such as Lavier's "Production of wild fish" (1976) provided insight into the development of scientific beliefs about salmon management and salmon ecosystems.

Wilkinson and Conner's "The law of the Pacific salmon fishery" (1983) provided an overview of the development of the Pacific Northwest fisheries, emphasizing the increasingly complicated conservation and allocation issues among individual harvesters, anglers, states and countries. It is particularly strong with regard to the plethora of jurisdictions (local, state, federal, tribal, and international) that any single salmon must transect during its life cycle. The authors' plea for increased coordination between jurisdictions was made prior to the creation of the Northwest Power Planning Council on the Columbia River; nonetheless, their comments are still valid today, as the Council has no implementation authority and does not include tribal membership.

Rutter's "Salmon fisheries in the Pacific Northwest" (1997) picks up where Wilkinson and Conner left off in the early 1980s. Rutter provides the most comprehensive discussion regarding current decision processes leading to annual harvest quotas and allocations in the American Northwest. The failure of the 1985 Pacific Salmon Treaty is succinctly explained, and various recommendations made to improve the current decision making system.

The most complete historical narrative for the region is Lichatowich's *Salmon Without Rivers: A History of the Pacific Salmon Crisis* (1999). As a biologist and former fishery manager, Lichatowich utilized a wide variety of fishery agency archives as well as contemporary research and popular publications. His historical narrative extends beyond the Columbia River focus of most publications on the Northwest salmon crisis. Lichatowich's thesis is that our technocratic culture of improving upon nature has been the source of our troubles. He sees the solution to our salmon crisis as a cultural shift that entails increased attention to and respect for natural processes, recognizing and facilitating the natural capabilities of salmon populations to recover if rivers are allowed to function naturally.

Salmon Fishers of the Columbia (Smith, 1979) was particularly useful in helping to clarify changes in fishing technology, and disputes between fishing gear groups in the Columbia River basin. Although limited in scope, Smith's book provides rich detail and insight to the economics and politics of the Columbia River fishery. Smith's monograph was particularly helpful in assembling the narrative regarding shifting property rights in salmon fisheries in the Columbia River basin.

The history of California's fisheries was the most difficult to piece together. McEvoy's *The Fisherman's Problem: Ecology and Law in the California Fisheries 1850-1980* (1986) does not chronicle the salmon fisheries per se. Nonetheless, it provided the core of the materials included in the Pacific Northwest narrative regarding California. Lufkin's "Historical highlights" in a volume he edited titled *California's salmon and steelhead: the struggle to restore an imperiled resource* (1991a) , supplemented and reinforced the commonalities and differences between the California salmon fisheries and those of Oregon and Washington.

The principal sources with regard to Washington State's salmon fisheries were Crutchfield and Pontecorvo's "Puget Sound Case" from their book, *Pacific Salmon Fisheries: A Study of Irrational Conservation* (1969) and a Natural Resources Consultants report entitled "Commercial fishing the State of Washington" (1986). Crutchfield and Pontecorvo's case study emphasize property rights and economic rents, and was most helpful for my chapters on rights and markets. The latter report emphasized the role of commercial fisheries in the Washington State economy, including the role of individual harvesters and Washington corporations operating in Alaska.

CHAPTER 3. HISTORY OF SALMON FISHERIES AND MANAGEMENT SYSTEMS

Total North Pacific salmon harvests have varied by jurisdiction over time (Figure 3.1), as a function of climate variability, freshwater habitat alteration, international politics, markets, technology and salmon management. For instance, WWI demand for salmon as a war-time ration prompted the first rapid increase in salmon production (Chapter 9). The leap in harvest and production levels would not have been possible without technogical innovations, including refrigeration, processing and canning technology (Chapter 7). Salmon harvests diminished everywhere in the first years of the Great Depression, but quickly rebounded because canned salmon was a relatively affordable depression-era food. Japanese harvests were shaped by international relations (e.g., collapse of harvests after WWII; Chapter 8). The relative dominance in salmon production between Japan, Russia, and Alaska will be explored in the jurisdictional narratives that follow.

A narrative regarding the evolution of management systems is intertwined with the jurisdiction by jurisdiction description of harvest trends. There are two distinct approaches to salmon management in the North Pacific -- rights-based and command and control (Table 3.1). Each jurisdiction has a comparable set of basic salmon management organizations at the federal level, but the ultimate decision-making authority and degree of federal oversight varies across jurisdictions. The clarity and stability of harvest rights varies significantly across jurisdictions (Chapter 6). Lastly, the right to manage salmon habitat is vested in state or federal hands everywhere but in Japan, and has been pursued more or less actively in each jurisdiction and over time (Chapter 5). Each of these themes is explored more fully in later chapters as noted.

This chapter will focus on the interplay between jurisdiction-level harvest trends (Figures 3.6, 3.7, 3.9, 3.12, 3.16, 3.18, 3.21) and salmon management. Management system features receiving particular emphasis are the legal framework for fisheries management, the organizations involved, and major shifts in regulatory approach.

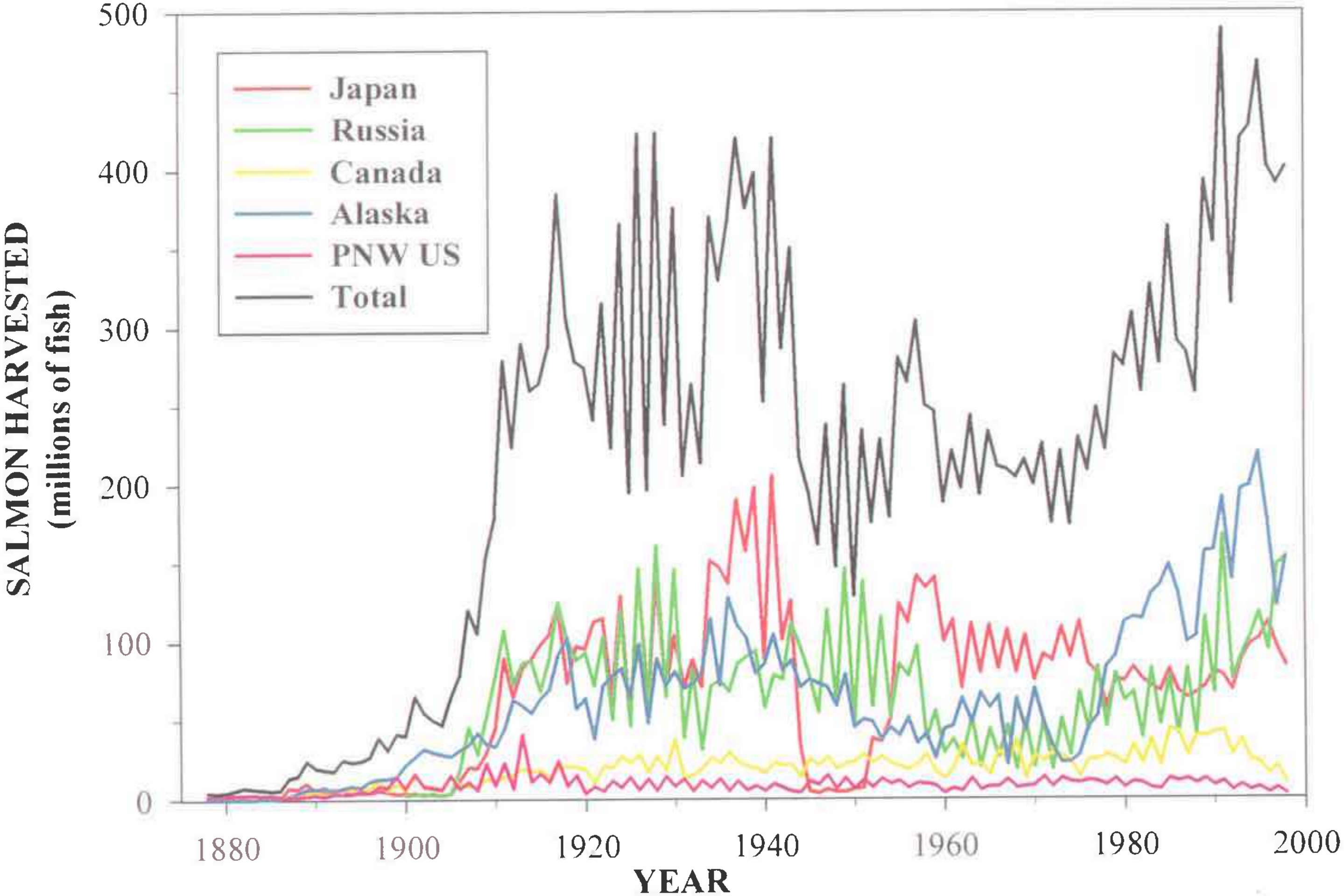

Figure 3.1 North Pacific salmon harvest, 1878-1998, by jurisdiction in millions of fish. Sources: Rogers (1999), Shepard et al. (1985a), Ianovskaia et al. (1989), Hare et al. (1999), and Byerly et al. (1999).

Table 3.1. Management basis and level of bureaucratization.

	Management basis	Center of control	Stability of commercial harvest rights	Habitat management
Japan	Communal and individual rights basis	Local Fishery Cooperative Associations, with prefectural concurrence; Tokyo for treaty fisheries	Stable, increasing rights over time	None in federal fisheries law; FCA role minor for salmon habitat
Russia	Command and control	Regionally based federal agencies, with Moscow's concurrence; Moscow for treaty fisheries	Stable 1932-1992, now unclear and unstable	Moderate in federal fisheries law, strong in federal forest law; enforcement poor
Canada	Command and control	Regionally based federal agencies, concurrence in Ottawa; Ottawa for treaty fisheries	Unstable over time, ethnic and gear-based regulations, increasing sports and native rights	Strong norms in federal fisheries and environmental law, but all implementation authority at provincial level
Alaska	Command and control	State management, district-level in-season management; states and Washington, D.C. for treaty fisheries	Stable; different dominant harvest groups before and after statehood (1959)	Moderate in state law, strong in federal law (>50% of salmon habitat in federal ownership)
Pacific Northwest US	Command and control	States, federal agencies, and judiciary, depending on fishery and location; states and Washington, D.C. for treaty fisheries	Unstable, gear groups phased out over time, increased native and sports rights	Moderate in state law, strong in federal law; federal ownership primarily in headwaters. Active investment in habitat protection since 1980s

3.1 Japan

Commercial fisheries in Japan have a longer history than in any other jurisdiction along the North Pacific, dating to the 17^{th} century. Japanese salmon fisheries occurred within Japanese waters, on the high seas, and in foreign waters. The nomenclature describing Japanese fisheries in these areas is confusing, because the jurisdictional boundaries shifted over time. "Coastal fisheries" refers to those conducted within three nautical miles of shore. "Offshore fisheries" refers to harvests conducted outside three nautical miles. Prior to 1977, these fisheries were beyond national boundaries, on the high seas. After 1977, offshore fisheries were within Japanese boundaries out to 200 nautical miles (Figure 3.2). "Distant water fisheries" refers to those conducted in Russian waters (within three nautical miles of shore), in the Bering Sea, and in the North Pacific Ocean prior to 1977. Since 1977, North Pacific fisheries within the 200-mile Japanese management zone have been considered offshore fisheries. At present, the only remaining distant water fisheries are conducted within the Russian 200-mile zone.

3.1.1 Pre-1870

During the Japanese feudal period, salmon fisheries on Honshu were owned by the feudal lord or han, who had obtained his rights as a land grant to a particular domain from the regime. Village fishing guilds conducted the fisheries. The guilds paid a percentage of their harvest to the han each year, on a communal basis. Even at its beginnings, over 90% of the wild salmon harvests consisted of chum salmon (Kaeriyama, 1989, 627).

The fisheries on Hokkaido evolved along a different pathway. The Matsumae domain on Hokkaido, granted in 1604, was not a land grant from the Tokugawa regime, but a grant for exclusive trade rights with the indigenous Ainu (Figure 3.3). Trade was initially on a barter basis, involving Japanese trade goods and Ainu products such as bear gall bladder, sea otter furs, and fish. High-ranking Matsumae retainers

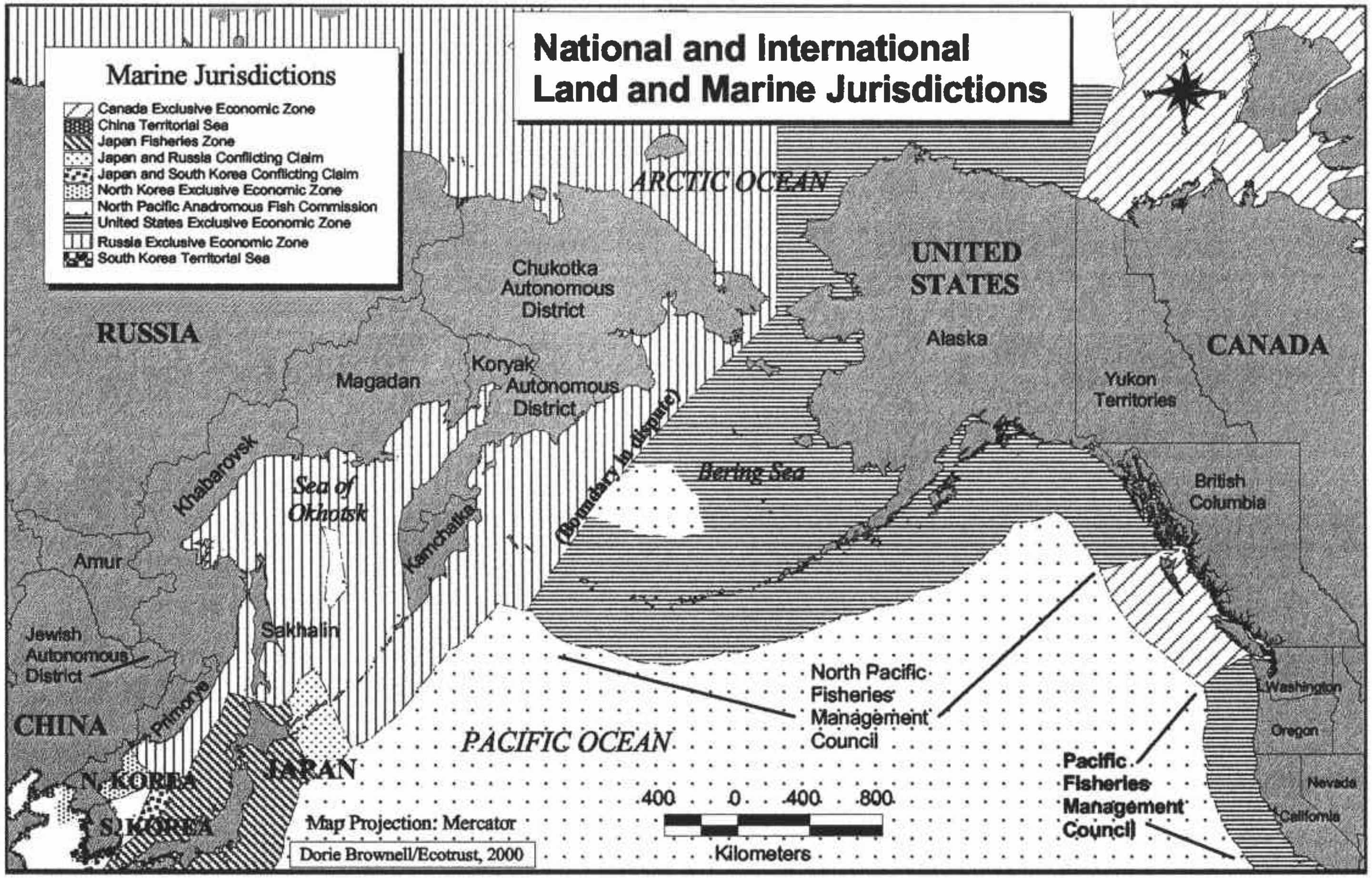

Figure 3.2. National and international land and marine boundaries after extended jurisdiction, 1977. Digital data provided to the Pacific Rim Project in 1995 by R. Goldman, Woods Hole Oceanographic Institution.

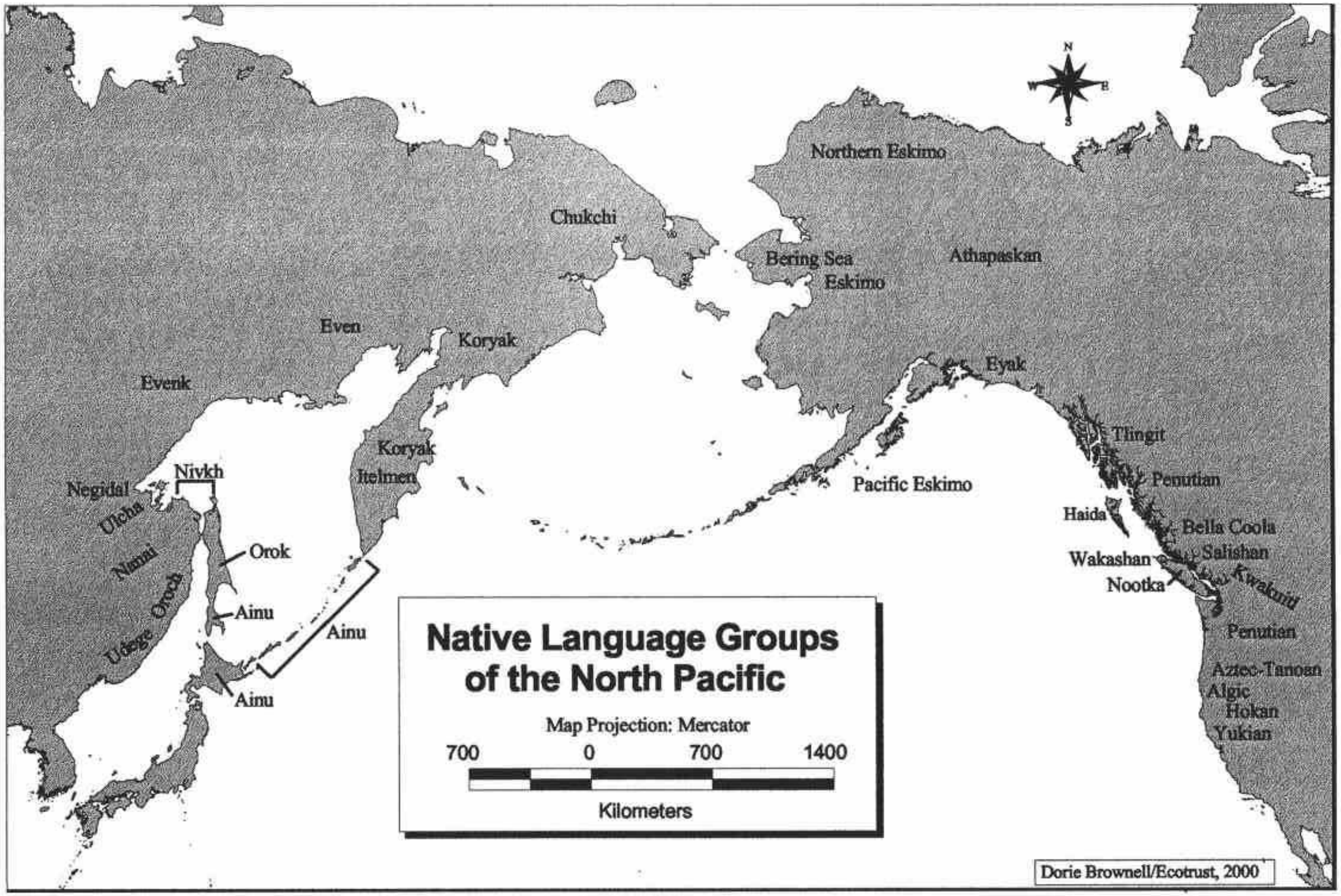

Figure 3.3. Native language groups of the North Pacific, ca. 1900. Sources: Fitzhugh (1994), Wolf et al. (1995).

were awarded trading posts on Hokkaido, with exclusive trade rights with the Ainu in their regions. By the mid-18th century, the trading posts in the Ainu district of Hokkaido (Ezochi; Figure 3.4) were contracted to merchant operators, providing a steady income to the Matsumae nobility without the daily work. The merchants gradually shifted from broad-spectrum trade to targeted fisheries for herring in the spring, trout in the summer and salmon in the fall. Salmon and herring were processed for fertilizer and dry-salted for human consumption. The fisheries were dependent upon Ainu labor (Howell, 1995, 24-28).

A gillnet fishery consisting of small, ethnic-Japanese family operators developed in parallel to the contract operations, in the Japanese district of Hokkaido (Wajinchi) in the 1670s. Although dependent on supply merchants, shippers, and marketing agents on Honshu for credit, the family fishery persisted and was the breeding ground for an aspiring class of capitalist fishers. In contrast to Honshu, taxation on Hokkaido was family-based rather than communal, based on the harvest capacity of a family fishery (Howell, 1995, 49, 58, 68).

Pound nets were introduced in the early 19th century, and were immediately adopted by some contract operators, despite official prohibitions. The new gear was controversial, because it was so efficient relative to small gillnet operations. The traps were more capital intensive than gillnets and required more labor to operate. The wealthier small operators were able to adopt the new gear, and began to challenge the contractors' fish marketing monopoly. Matsumae-authorized contract operators would have liked to retain a monopoly on the use of pound nets in Ezochi. However, the Ainu population was declining because of disease and Japanese laborers from economically depressed northern Honshu were migrating to Hokkaido to fill the void. By the mid-1800s, the Tokugawa shogunate was more interested in erasure of Wajinchi/Ezochi differences, in order to clearly establish Japanese dominion to the territory in the face of increased Russian and English exploration in the area (Howell, 1995, 68-76).

Conservation measures for high-value species developed as early as the mid-1700s (Ruddle and Akimichi, 1989). Measures included time and area closures,

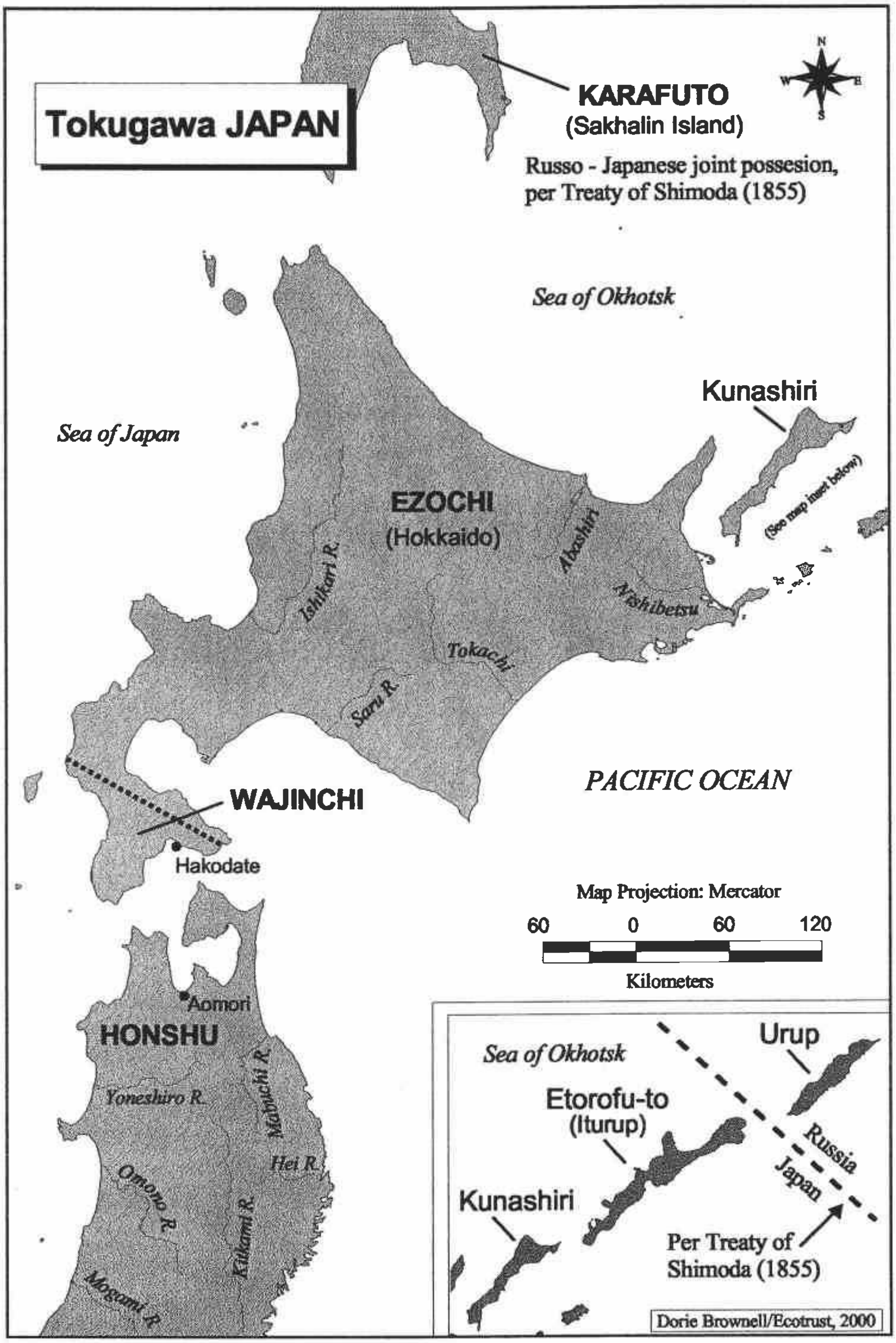

Figure 3.4. Tokugawa Japan. Sources: ESRI Digital Chart of the World (1993), Howell (1995).

spawning ground protection, and transfer of salmon from lower river to spawning areas upstream. These early practices appeared to stabilize salmon populations, and many persisted despite steady fishing pressure for more than a century (Matsuda, 1992, 161). By the 1860s some stocks were in decline. The first attempt at artificial rearing was made on the Miomote River in 1863 (Kaeriyama, 1989). After two decades of internal discord, the Meiji Restoration occurred in 1868. The new administration was concerned with westernization and trade. Administration of Hokkaido was transferred to the Hokkaido Development Agency.

3.1.2 1870-1896

All coastal waters and resources were briefly nationalized in 1875, but chaos ensued and the customary rights system reinstated in 1876. By the end of the decade, the Meiji government vested ownership of the fisheries in the prefectures, the local administrative units that replaced the feudal domains.

The fishing sector became professionalized during this period: the Japan Fisheries Association was established in 1882, and the first industry exhibition took place the following year in Tokyo. The national Bureau of Fisheries was established in 1885, largely to resolve disputes among fishers resulting from the chaos over shifting fishing rights. Reflecting interest in artificial cultivation to replace declining wild stocks, the Fishery Training Institute (Tokyo University of Fisheries) opened in 1889, to provide skilled cadres for fisheries and fish culture (Japan Fisheries Association, 1998).

Prosperity in the fishing sector was very skewed in the aftermath of the Meiji Restoration, with most fishers poor and getting poorer, while fishing proceeded at uncontrolled levels. Economic stratification in the fisheries was, in part, an unintended side-effect of land privatization laws in the late 1870s (Chapter 6). The offshore fisheries were increasingly dominated by non-resident merchants and local bosses, and small fishers were squeezed out (Sato, 1992, 74-75).

Overall effort in the fisheries increased, leading to a surge in harvests in the 1880s, primarily centered upon the rich Hokkaido fishery. Salmon fisheries shifted from predominantly riverine to coastal fisheries in the early 1880s. The fishing grounds were no longer monopolized by the feudal domains and the number of harvesters increased steadily, because of northward migration from Honshu to Hokkaido. Simultaneously, a change in pound-trap design improved fishing efficiency, doubling harvests and requiring less labor. Lastly, agriculture was expanding on Honshu, generating a strong demand for fertilizer (Shepard et al., 1985a, 8; Howell, 1995, 109-110). The average annual catch of wild chum was about 7 million fish per year between 1879 and 1893 (Figure 3.5).[1] Wild salmon harvests peaked in 1889, at 11 million fish, and subsequently went into sharp decline throughout the 1890s and 1900s (Kaeriyama, 1989, 627).

The government responded to declining wild salmon runs in three ways – authorizing village Fishermen's Unions, investing in hatcheries for artificial cultivation, and encouraging fishing on the high seas. The Fishermen's Union Regulation was instituted in 1886, authorizing the precursors to contemporary Fisheries Cooperative Associations (Sato, 1992, 75). The purpose of the unions was to minimize local disputes over fishery access, regulate gear, prevent overfishing, and standardize product inspections. Unions were already operating on Hokkaido by 1884, and in other areas by 1886. Although the intentions were positive, on Hokkaido the unions were heavily dominated by land-owning pound-trap operators, who restricted access of small gillnet operators to fishing and processing areas (Howell, 1995, 99). The first national fish hatchery was built by the Bureau of Fisheries on the Ishikari River in 1888 (Figure 3.4; Sato, 1992). Soon there were two government-owned and fifty private hatcheries operating in Japan. Riverine and coastal harvests continued to decline because of overfishing and poor hatchery technology.

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[1] Despite early experimentation with artificial cultivation, it is unlikely that hatchery fish contributed to the coastal and offshore fisheries.

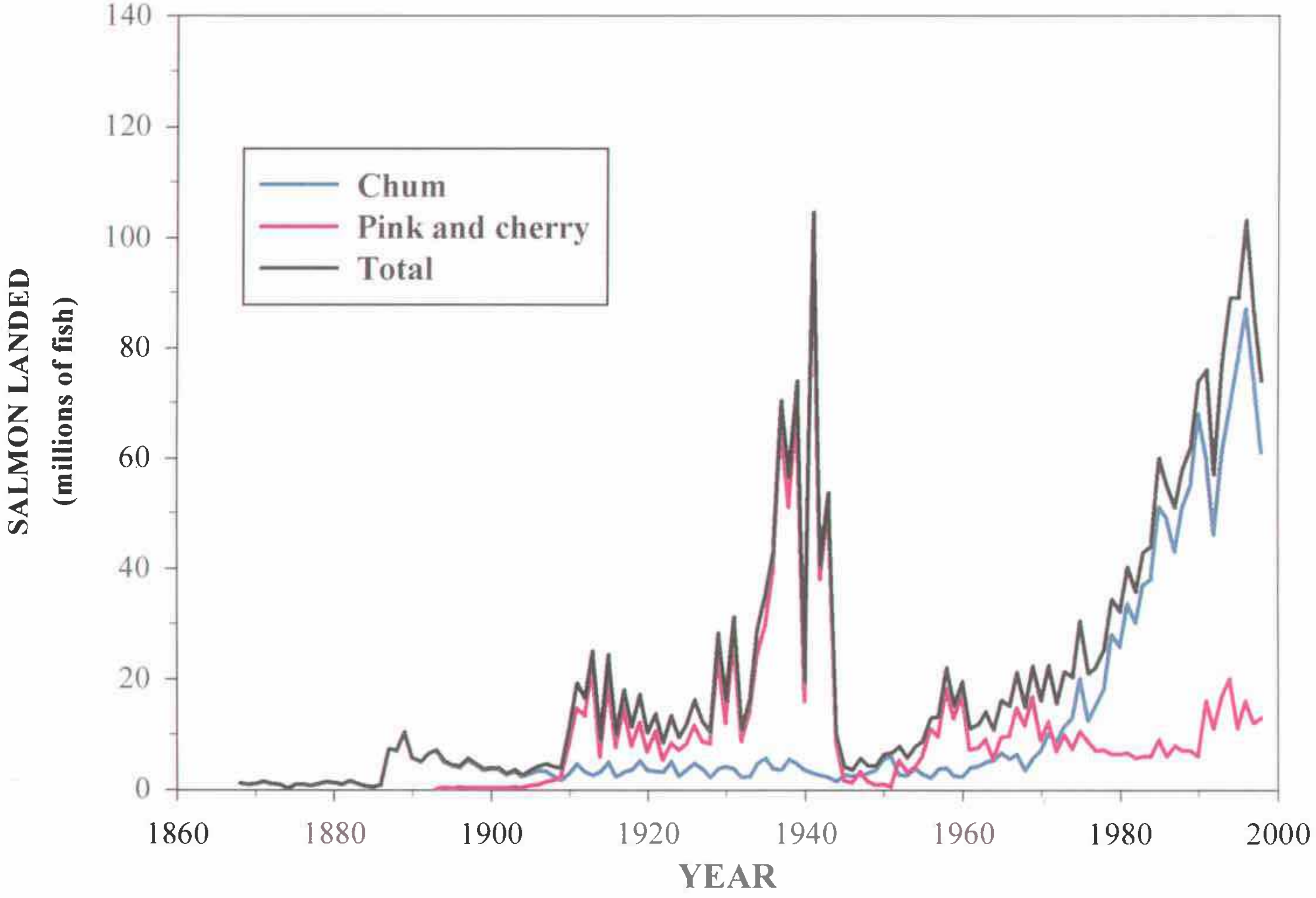

Figure 3.5. Japan coastal and offshore commercial salmon harvests, 1868-1998, in millions of fish. Sources: Rogers (1999), Shepard et al. (1985a).

Lastly, the government enacted a law that awarded bonuses for fishing and hunting on the high seas, including the Bering, Japan and Okhotsk Seas (Mandrik, 1994, 158). There were already trading posts and a few contract fishery ventures in the southern Kuriles and on Karafuto (Sakhalin Island; Figure 3.4) prior to the turn of the century. Favorable laws, declining domestic fish stocks and intense competition in Japanese waters led more merchants to move their operations to Japan's northern waters (Howell, 1995).

3.1.3 1896-1914

Hatchery construction on Hokkaido increased in the 1890s. Early hatchery practices included interbasin transfers, and complete blockage of rivers to harvest reproductive materials, with a subsequent complete loss of some wild runs. Wild chum populations decreased with the increase in hatchery juveniles released. Wild chum runs were substantially depleted by a combination of hatchery practices and overfishing by the teen years [Kaeriyama, 1992 #1257, 58]. The Meiji Fisheries Law enacted in 1901 is the basis for all contemporary Japanese fisheries legislation. The Meiji Law abolished village fishing unions, replacing them with formalized fishery associations. The associations were to be responsible for managing fishing rights. This was a major change, as for the first time it handed control to the fishermen themselves, rather than the village governments and existing power structures (Kalland, 1990, 192). Shortly before the passage of the Meiji law, all rivers were nationalized, formalizing restrictions on in-river salmon harvest and other activities. Restrictions on in-river harvests eliminated legal Ainu subsistence fishing (Kayano, 1998b, 42).

Distant-water fishing and trading associations were authorized in 1902. The Association of Marine Industries of Primorye Province (Roryo Enkaishu Suisan-Kumiai), included the vast majority of Japanese distant-water operators in one powerful conglomerate (Vakhrin, 1996c, 13).[2] Japanese distant water fisheries were

[2] The entire Russian Far East was a part of Primorye Province at the time.

facilitated by the advent of motorized boats in approximately 1903 and radio communications during WWI (Fujinami, 1989). Coastal salmon landings increased around 1910, perhaps as a result of expanding land-based fisheries in the southern Kuriles and on Karafuto (Figure 3.5). Distant-water fisheries, comprised primarily of leases in Russian waters, averaged 81 million salmon per year during this period, with variability owing primarily to natural variation in pink salmon run strength (Figure 3.6)

The Bureau of Fisheries was incorporated into the Ministry of Agriculture and Commerce in 1911 (Japan Fisheries Association, 1998).

3.1.4 1915-1946

World War I spurred demand for food-grade salmon and fish fertilizer. Japanese domestic production consisted primarily of dry-salted fish, roe and fertilizer, rather than canned salmon sought after as battlefield rations. The first Hokkaido cannery began operating in 1913, producing primarily for the British market (Vakhrin, 1996a). Coastal salmon harvests maintained an average of almost 6 million fish per year during this period, despite a dip during the early years of the Great Depression (Figure 3.6). Judging by harvest statistics and contemporary harvest patterns, it is probable that land-based drift gillnet fleets (offshore fleet) expanded into the Japan Sea at this time, targeting Russia-bound pink and cherry salmon. This fishery expanded rapidly before and during WWI (Figure 3.5).

Japanese fishing communities suffered deep poverty during the Great Depression. The largest corporations held most of the fishing rights, and leased them back to independent fishers or fishing associations. Other sites were left idle. The Meiji Fisheries Law was amended to give fishing associations additional leverage in the marketplace, and means to finance small operators. Large corporations consolidated their holdings, and amalgamated fish holding companies were created uniting pound trap operations on Hokkaido and Karafuto (Howell, 1995, 117; Ruddle and Akimichi, 1989, 344). Russian harvest leases were held primarily by large companies, and harvests appear to have been consistently high with the exception,

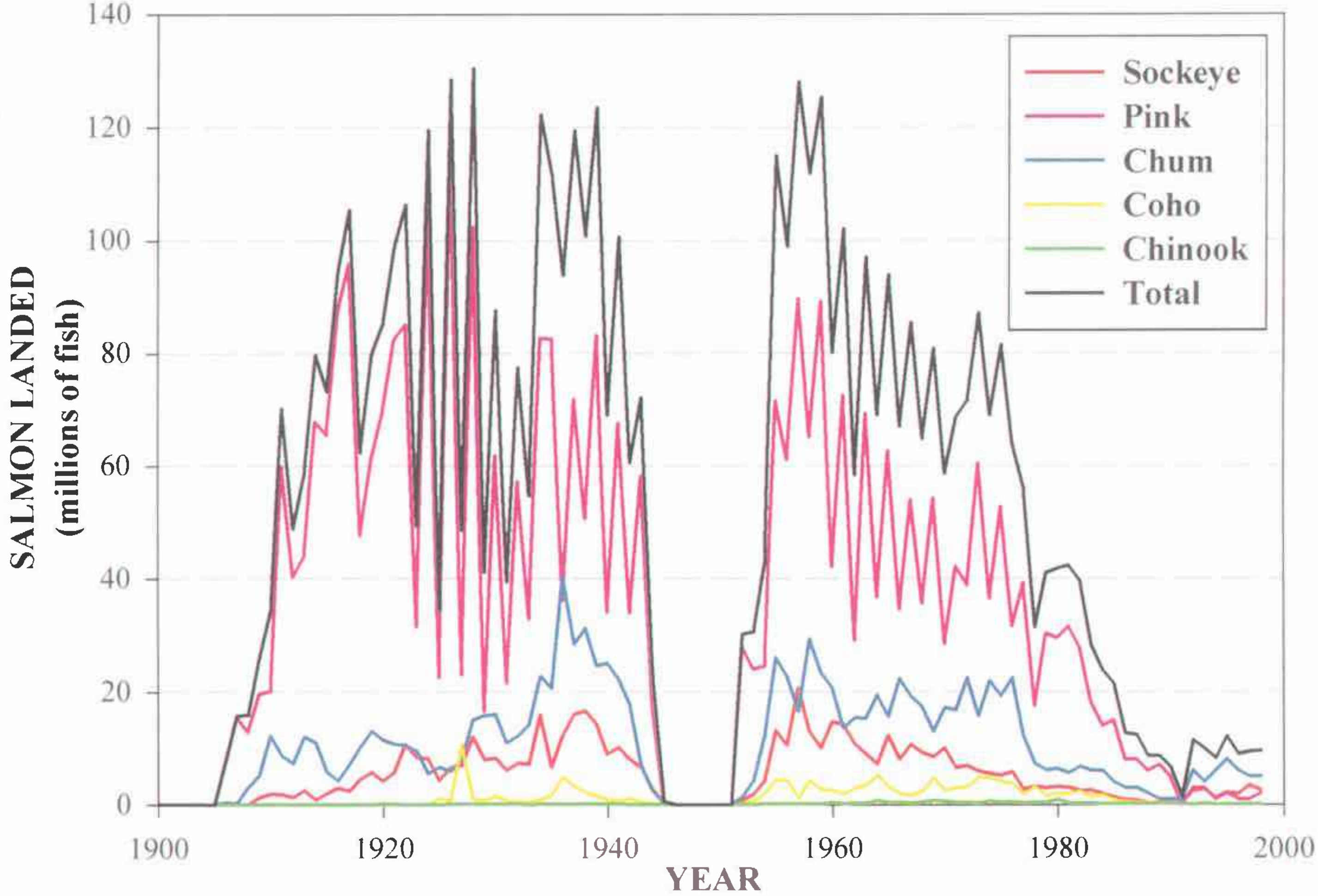

Figure 3.6. Japan distant-water commercial salmon harvests, 1906-1998, in millions of fish. Sources: Rogers (1999), Shepard et al. (1985).

again, of the first years of the Great Depression (approximately 1929-1933; Figure 3.6).

The Great Depression also hurt private hatchery operations. The central government took control of artificial cultivation activities on Hokkaido. Most of the hatcheries at the time were privately held, and many were ineffective. Thirty-eight of the private hatcheries were transferred to the government, and another twelve or so were closed down (Matsuda, 1992, 164).

In 1937, Japan began gearing up for war and government took increased control over food production. "Redundant middlemen" in the fishing industry were drafted for work in ammunition factories. Fisheries associations were reorganized as part of the war effort, with one association recognized per village or town. The associations were perceived as critical to war-time preparedness, in that members were the eyes and ears of Japan along the coasts. During WWII, local fishery cooperative presidents were appointed directly by the prefectural governor, whereas today they are elected by the full membership (Ruddle and Akimichi, 1989, 344).

Perhaps as another manifestation of preparation for war, Japanese fishers began to intercept increasing numbers of Russian-bound pink and cherry salmon in a land-based driftnet fishery in the Northern Kuriles and in the early Kamchatka mothership fishery in the Sea of Okhotsk.[3] These harvests may have led to the almost doubling of coastal pink and cherry salmon landings between 1937-1941, from 66.8 to 101.6 million fish (Shepard et al. 1985, 13-14; Figure 3.5).

Presumably there was an increase in fishing pressure on wild salmon runs in Japan's rivers, to meet war-time food needs. All-out harvest pressure in Japanese rivers during WWII, in conjunction with the intense industrial development drive in the aftermath of WWII, likely sealed the fate of many of Japan's wild salmon stocks. There was a slow-down in all of Japan's offshore and distant water fisheries by 1944, because fuel and labor resources were needed elsewhere. Cyclical marine survival

[3] Japan pioneered the use of motherships, or floating processors, working with a fleet of smaller harvesters, usually gillnet vessels. The Kamchatka mothership fishery was a Japanese adaptation to the Soviet strategy to Russianize the shore-based fisheries in the 1930s.

conditions may have also played a role. The northern Kuriles and Kamchatka fisheries continued through the 1944 fishing season, ending prior to the 1945 season when the United States bombed Hiroshima and the Soviet Union evicted Japan from the Kuriles, southern Sakhalin and all Kamchatka leases (Figure 3.7; Vakhrin, 1996). Distant harvests were at or near zero through 1951 (Figure 3.6).

3.1.5 1947-1975

General McArthur's Allied Occupation Administration was instrumental in pushing for increased democratization in fisheries ownership and management in Japan after WWII. Anti-trust laws were promulgated, outlawing the large amalgamated companies controlling the domestic herring and salmon fisheries (Howell, 1995, 117). The Fishery Cooperative Association Law (1948) converted fisheries associations to democratic membership organizations, with membership limited to active local fishermen (see Chapter 6). Amendments to the Meiji Fisheries Law (1949) created a new type of organization, Sea Area Regulatory Commissions (SARC), to plan, review and coordinate regional fisheries and to mediate between the central government, the prefectural government and the Fishery Cooperative Associations (FCAs) (Ruddle and Akimichi, 1989, 345). Implementation of the new laws was challenging and time consuming. The National Federation of Fisheries Cooperative Associations, Zengyoren, played an instrumental role in the transition process (Sato, 1992). The Japan Fisheries Agency was established in 1948 within the Ministry of Agriculture, Forestry and Fisheries (Japan Fisheries Association, 1998).

Fisheries Cooperative Associations now manage their own fisheries. FCA members are divided into study groups (gear groups), which draw up formal management plans for their fisheries. Each plan must be approved both by the association membership and by the Prefectural Fisheries Agency, with the advice of the relevant Sea Area Regulatory Commission. License renewal for a particular fishery is contingent upon the adequacy of the FCA's Management Plan and historical success in operating the fishery for maximum output. In addition to reviewing the

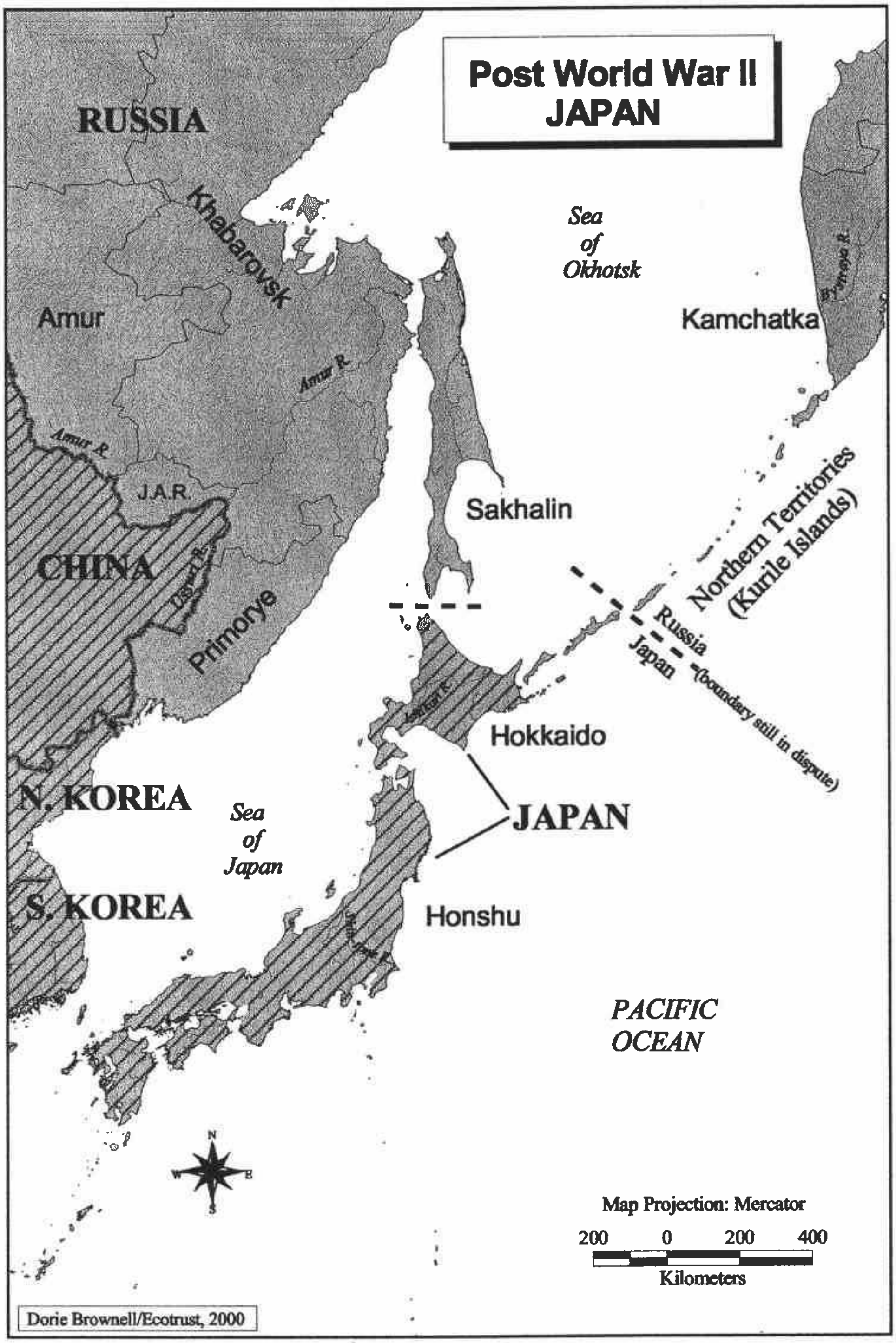

Figure 3.7. Post-WWII Japanese boundaries. Sources: ESRI Digital Chart of the World (1993), Howell (1995).

conservation basis for FCA management plans, the Commissions assure that Prefectural fisheries management is integrated across FCA sea areas and complies with national fisheries management policy (Lim et al., 1995, 200-202). The Minister of Agriculture, Forestry and Fisheries and the governor of the prefecture share jurisdiction over the Sea Area Regulatory Commissions. Six or more commissioners are appointed by the governor (fishery specialists, public representatives) and the remaining nine are elected by the FCA membership.

Distant water and offshore fisheries resumed after the establishment of new international access regimes such as the Tripartite Convention, governing harvests in international waters of the Bering Sea and North Pacific (Chapter 8). By 1957, total Japanese salmon harvests had regained mid-1930s levels (Figure 3.8; Shepard, 1985a, 28). Expansion of distant water fisheries in international waters of the Bering Sea and North Pacific was facilitated by war-time technical innovations such as sonar, radar, and synthetic fibers, incorporated into fishing technology for fish finding, navigation and improved fishing gear.

Japanese policy favored economic and industrial growth over all else, and fisheries were a key component of growth and development strategies (Boxer, 1989, 197). For example, the Fisheries Resource Conservation Law (1952) mandated the reinitiation of the salmon hatchery ("marine ranching") program. Prefectural hatcheries supplemented national hatchery programs, in a strategy to buffer fishing communities from the effects of high seas harvest limitations under the Tripartite Convention and the elimination of Soviet shore-based fisheries.

In the late 1940s, coastal salmon harvests were near an all time low (Figure 3.5). Depressed coastal harvests in the 1950s and early 1960s strained the economies of local fishing villages. The booming urban industrial economy drew many young people to the cities, beginning a prolonged and continuing out-migration of young fishers seeking an improved standard of living (Asian Productivity Organization, 1989, 4). Hatchery research acquired new urgency to provide a technical solution for disappearing wild salmon runs and an economic means to support remote rural populations.

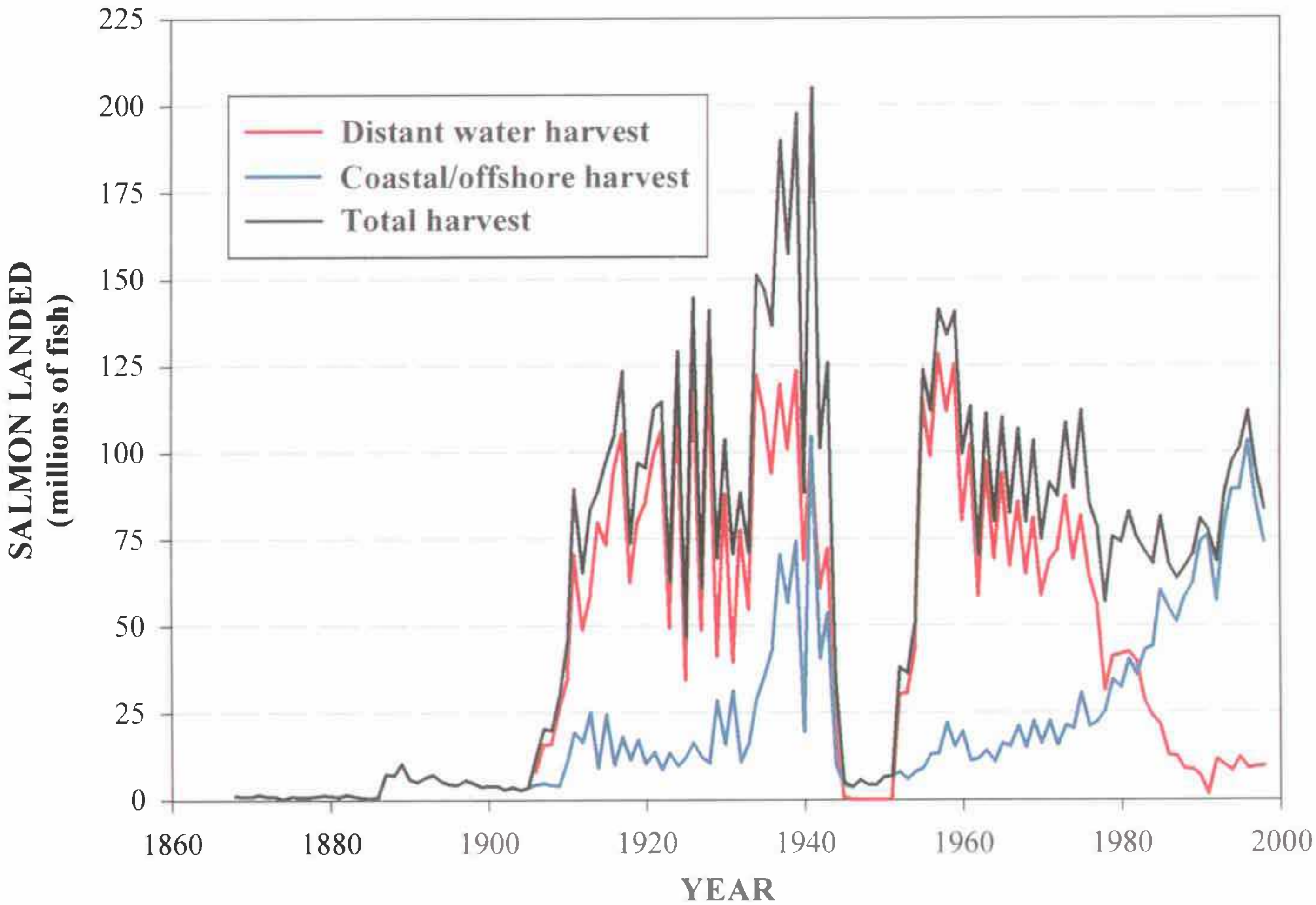

Figure 3.8. Japan commercial salmon landings, coastal and offshore plus distant-water harvests, in millions of fish, 1868-1898. Sources: Rogers (1999), Shepard et al. (1985a).

A national subsidy was created for salmon marine ranching programs (hatcheries) on Honshu in 1956. The vast majority of Honshu hatcheries were owned by Fishery Cooperative Associations (FCAs; 134 of 138 in 1992), and coordinated by prefectural fisheries agencies. The major Hokkaido hatcheries were operated by the central government, and coordinated by the National Hokkaido Salmon Hatchery (Matsuda, 1992, 164-165). In both regions, FCA members are responsible for salmon collection for hatchery broodstock, at FCA-operated weirs. From 1962-1966, researchers conducted experiments, feeding chum various diets for varying durations prior to release. Feeding programs were fully implemented by the early 1970s, and researchers saw a doubling of return rates from 1 to 2% (Kaeriyama, 1989, 628). Over 90% of the fry released are chum salmon, with smaller releases of pink, cherry and sockeye.

Hatchery productivity improved just as the distant-water fleet began to experience troubles. Given Japan's dependence on imported oil, the fuel crises of the 1970s were felt acutely by Japanese businesses. The first oil crisis in 1973 exacerbated the decline in Japan's distant water salmon harvests, and led to special government loan programs for fuel (Figure 3.6; Japan Fisheries Association, 1998).

3.1.6 1976-2000

Great dislocations occurred in the distant-water fishing industry after the North Pacific countries extended fisheries jurisdiction to 200 nautical miles (Figure 3.2 and Chapter 8). Japanese harvests were restricted, because the area of the high seas with open fisheries access declined. Special budgetary and tax measures were enacted in order to implement a joint Ministry of Forestry and Fisheries-Japan Fisheries Association economic adjustment strategy. Loan programs were established to compensate companies operating distant water fleets, and to provide emergency loans for small to medium sized vessel owners and support industries (Japan Fisheries Association, 1998). Decreases in total Japanese salmon harvests were mitigated by increased hatchery returns beginning in 1977 and a reallocation of effort on the high seas and within the new Japanese fisheries zone (Figures 3.5 and 3.6; Kaeriyama, 1989, 627; Shepard, 1985, 10-11).

The Soviet Union gradually reduced Japanese quotas in the 1980s for Russian-origin salmon harvested within the Soviet and Japanese fisheries. By the mid-1980s, it was clear that restrictions on high seas salmon harvests were forthcoming, and in 1989 the Japan Fisheries Association and the Japan Fisheries Agency developed a plan to restructure the fleet, including a vessel buy-back program (Japan Fisheries Association, 1998). The largest distant water companies refocused their efforts away from harvest to processing and imports, and overall remain profitable operations (Murdo, 1995).

Despite reductions in distant water fishing, the trend in total Japanese harvests has been steady since 1976 (Figure 3.8). Between 1976 and 1995, harvests averaged 72.5 million fish or approximately 164,000 MT. Because of exceptional hatchery returns and new fishing agreements with the Russian Federation, total salmon harvests in 1995 were over 101 million fish, greatly exceeding peak harvests of 11 million Japanese-origin salmon in 1889 (Figure 3.8). The distant-water harvest component has decreased from a peak of 130 million fish in 1928 to an average of 9-10 million salmon per year in the 1990s, with a post-WWII low of 1.4 million salmon (12,000 MT) when high seas fisheries were first off limits in 1991 (Hiroi, 1998, 23). The only distant water operations still in existence are within Russia's territorial sea and Exclusive Economic Zone (EEZ). Coastal and offshore fisheries have accounted for over 80% of the salmon harvests since 1986. Chum salmon comprises at least 80% of the average annual coastal salmon harvest (Figure 3.5; North Pacific Anadromous Fish Commission, 1997; North Pacific Anadromous Fish Commission, 1998; North Pacific Anadromous Fish Commission, 1999).

Present-day distant water Japanese fisheries operating within the Russian EEZ are may be more profitable than coastal and offshore sectors, but the greatest growth over the past decade has been within the Japanese fishery zone. Technology has improved profitability, with the advent of Global Positioning Systems (GPS) for navigation and biotechnology in hatchery production. However, the Japanese fishing industry and managers are concerned that harvesters are aging, and few young people are entering the business. The Japanese Fisheries Agency regularly collects annual statistics on fishery household and corporate incomes and expenditures, and the overall trend in operating profits salmon and all other fisheries has been negative (Murdo, 1995).

Efforts are being made to improve conservation measures and effort limitation in the coastal and offshore fisheries, to assure continued productivity and profitability. The Fishery Resources Development Promotion Law was amended in 1990, to provide a framework to support management and conservation measures by Fishery Conservation Associations with a government loan program (Murdo, 1995).[4] The last major component of the adjustment to the closure of high seas fisheries was a concerted effort to further increase hatchery production of salmon (Gritsenko, 1994). The number of hatcheries on Honshu, for instance, increased from 111 in the late 1970s (Shepard et al., 1985b, 9) to 138 by 1992 (Matsuda, 1992, 165).

Most salmon now harvested within the Japanese zone are either artificially cultured or Russian-origin fish, with a large culture program for chum, and smaller programs for pink, cherry and sockeye salmon. Net-pen rearing of coho salmon has recently been introduced in Japan. Hiroi estimates artificial cultivation to be very profitable, given that the value of harvests is five times greater than expenses for artificial propagation (1998, 23-27). This estimate apparently does not take into account the cost of harvesting or subsidies to the coastal fishing sector.

Return rates for chum have continuously exceeded 3% per year since the 1984 brood year, and exceeded 10% between 1989 and 1996 (Kaeriyama, 1999a, 156). Kaeriyama and Matsuda attribute improved return rates to improved hatchery technology (Matsuda, 1992, 166; Kaeriyama, 1999a, 159). However, 1976 marked the beginning of a an ocean regime favorable to Alaskan and Eastern Pacific salmon stocks, and much of the increase in survival may have been due primarily to improved

[4] In 1990, there were over 2,000 active FCAs, composed of approximately 535,000 fishers. The Cooperative sector is responsible for over 90% of Japan's seafood production in quantitative terms (Sato, 1992, 72).

ocean conditions.[5] Chum returns peaked in 1996 at approximately 87 million fish (Figure 3.6). Chum returns and coastal harvests have decreased since the 1997 season. Pink returns are also declining. Although 1999 harvests were between 75-85% of their 1998 levels, coastal harvests are still at historically high levels [Figure 3.6; \Noakes, 1999 #1193, 1]. We may be seeing a regime shift in ocean climate conditions (Taylor and Southards, 1997). Others argue that we are seeing a decline in both size at maturity and absolute numbers of chum salmon, because hatchery programs in combination with wild salmon production have exceeded ocean rearing carrying capacity (Heard, 1998).

Japanese culture programs have emphasized pink and chum selection for fish that, in the wild, would have had the longest freshwater return migrations, as they are the most silvery in appearance and fetch a higher price in the market place. Success in propagation has not been evenly distributed geographically, and hatchery researchers see a need to focus on problem areas. There is also now an increased focus on cherry and sockeye salmon, as they are very valuable market species (Hiroi, 1998, 27).

Most of the salmon harvest within the Japanese EEZ occurs in Prefecture-licensed pound net (trap) fisheries or inter-FCA coastal gillnet fisherises for chum and pink salmon. Recent FCA conservation measures include prescribed fishing seasons, area and gear regulations. Net removal is required if spawning runs are perceived to be inadequate (Hiroi, 1998, 23). Until recently, the Fisheries Agency prepared stock forecasts. At present, Japan has no formal stock forecast or harvest planning process (Kaeriyama, 1999b; Nagata, 1999).

Sports fishing in Japan is increasingly popular. Angling for salmon is prohibited in Japan's rivers and bays, except for juvenile cherry salmon (*O. masu*). Salt water sport fishing is very popular for chum, pink and cherry salmon. Japanese

[5] Kaeriyama (1999) conducted statistical analyses of the relationship between Hokkaido chum salmon return rates, body weight class, proportion of fry reared prior to release and the atmospheric circulation index (ACI) for 1977-1991 brood years. He concluded that rearing rate and body weight were the key factors ($r=0.80$, $P<0.001$ and $r=0.83$, $P<0.001$). However, given that nearshore ocean conditions at emergence are the critical factor for juvenile survival, the ACI may simply be a poor measure of the effect of ocean conditions upon Hokkaido juvenile salmon survival.

sport fisheries are consumptive fisheries, there is not a well-developed culture of catch-and-release. Pressure on cherry salmon, referred to as trout in Japan, is particularly acute. Sports harvesters fish for juvenile cherry salmon in freshwater, except during the smolt outmigration.

Freshwater cherry salmon sport fisheries are administered by Inland Fishery Cooperative Associations, which set their own regulations and fees for access. There may be several such Associations on a large river, and they may or may not have agreements among themselves to coordinate policies regarding fish stocking, catch regulations, and mutual recognition of sport fishing licenses (Kamoshida, 2000). Japan has no uniform licensing and no system of sport fishing regulations at the national level. Nagata (1999) predicts that licensing and regulation are not far off, as conservation-minded sports anglers are beginning to lobby for them.

3.2 Russia

Although colonization of Siberia and the Russian Far East began in the mid 17th century, commercial fisheries did not develop until the end of the 19th century because of the vast distance from markets and chronic shortages of capital and labor. Early Russian trappers' and explorers' outposts were patchy and sparse across the landscape, their distribution in the Far East dependent on relations with native peoples and the new Manchu rulers of China. Cereal crops were difficult to grow during the short and capricious summers, and there were no analogs of the American bison to feed the explorers. Vast quantities of salmon were not encountered until Russian explorers first reached the Amur River in 1639.

3.2.1 Pre-1870

Salmon were an essential component of the diet of the aboriginal peoples of the Russian Far East. Coastal populations of reindeer herders (Evenk, Even, Koryak, Chukchi and Yakut; Figure 3.3) relied to varying degrees upon salmon fisheries and marine mammals. The Nivkh, Orok and Ainu of Sakhalin Island were primarily salmon eaters, and secondarily terrestrial and marine hunters. The peoples of the

Amur and Primorye were to varying degrees salmon eaters, terrestrial and marine hunters. Salmon were the mainstay of the Kamchatka aborigines (Koryak, Itelmen and Ainu; Figure 3.3), who consumed an estimated 900 fish per person per year (between 1,260 to 3,150 kg/person/year) to feed their families and sled dogs (cited in Vakhrin, 1996a, 78).[6] The Nivkh of the Amur and northern Sakhalin may have harvested 383 fish or 1,532 kg/person/year to feed themselves and their dogs. The indigenous Amur fishery is estimated to have harvested 10-12 thousand metric tons of salmon per year, or approximately 4% of the total salmon run (cited in Zolotukhin et al., 1997, 58).

In the 1840s, the Russian Far East was under the jurisdiction of the East Siberian Governor Generalship of Nikolai Muravyov, based in Irkutsk (Figure 3.9). The Governor Generalship extended to the Pacific, encompassing the shores of the Sea of Okhotsk and the Kamchatka and Chukotka peninsulas. The Russian Far East was sparsely settled, with widely dispersed outposts at Okhotsk, Petropavlovsk and Albazino. Governor General Muravyov was part of a circle of Russian intellectuals who were eager to extend the Russian empire into the Amur River basin to forestall possible colonization by other powers, notably Great Britain. The Amur basin attracted Russian interest because of its potential to support irrigated agriculture and navigation (Bassin, 1988).

Governor General Muravyov authorized surveys of the Amur region, including Sakhalin Island and Tatar Strait, between 1851 and1853. Sakhalin Island was annexed in 1853, in order to protect Kamchatka and the Okhotsk littoral against the Allies in a second front of the Crimean War (Gibson, 1968). Seasonal Japanese trading outposts existed on Sakhalin at the time, and the Japanese denied the Russian Geographical Society access to southern Sakhalin (Bassin, 1983, 251). Russian annexation of Sakhalin led to the Treaty of Shimoda (1854), which proclaimed Sakhalin Island a

[6] Author's comments in parentheses. According to contemporary statistics, Russian salmon harvests range in average weight from 1.4 kg for pink salmon, to 3.5 kg for chum or coho (North Pacific Anadromous Fish Commission, 1999) 16. Thus 900 fish/person/year would range from 1,260 kg/person/year to 3,150 kg/person/year. Pink salmon is the most abundant species on Kamchatka, but is not favored for preservation because of its low oil content.

joint, unpartitioned territory of Russia and Japan, and placed the border between the Kurile Islands of Iturup and Urup (Figure 3.4). Japanese fishery development along Sakhalin accelerated thereafter (Mandrik, 1994, 153).

Lacking military support from St. Petersburg, Governor-General Muravyov raised an army among his Transbaikal Cossack settlements in the late 1850s. He ordered the creation of new Cossack settlements every 12-18 miles along the Amur River in 1857, and along the Ussuri River in 1859. The newly created kazachestvos, or Cossack regimental settlements, were to protect the border and defend Amur steamship commerce. As elsewhere in Russia, the kazachestvos had special territorial rights and exercised self-governance on their border territories (Malozemoff, 1958, 2).

Governor General Muravyov's initiatives, permitted Russia to acquire title to some of the richest salmon-fishing grounds in the Far East. Russian acquisition of the left bank of the Amur River was recognized in the Sino-Russian treaties of Aigun and Tianjin (1858). The Manchu text of the latter treaty, which contained provisions for border demarcation, were loosely translated and left an opening for Muravyov to claim joint jurisdiction of the territory on the right bank of both the Amur River and one of its major tributaries, the Ussuri (Figure 3.9). By signing the Treaty of Beijing (1860), the Qing Dynasty ratified the previous two treaties and surrendered the right bank of the Ussuri River (Primorye) and access to the Sea of Japan. In exchange, Russia exercised its good offices to negotiate the withdrawal of British and French troops from Beijing during the Opium War (Stephan, 1994, 48-49).

Immediately thereafter, Russian Far Eastern policy stagnated. Settlers previously destined for Kamchatka and Okhotsk now settled along the upper Amur River. Alaska was sold to the United States in 1867, eliminating the need for the newly acquired Amur as a route for provisioning distant colonies. The Treaty of Tianjin had opened a series of Chinese ports to Russian traders, thus Kiakhta in the Upper Amur basin lost its significance as the sole trade fair for China trade. Internal communications within the Russian Far East were poor, and Muravyov's successors in distant Irkutsk did not actively use their proconsular authority. Manchu bandit raids

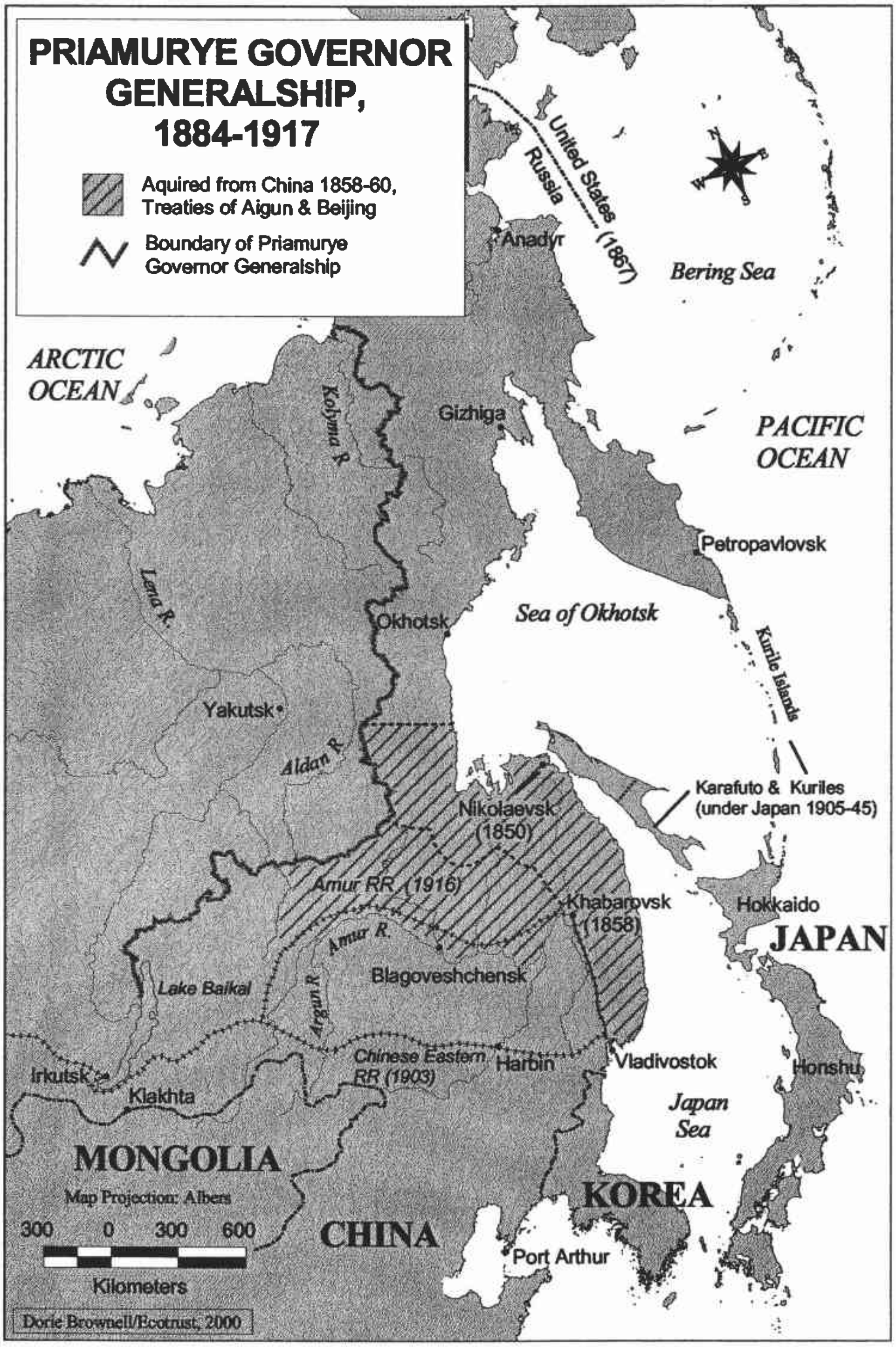

Figure 3.9. The Priamurye Governor-Generalship, Russian Far East, 1884-1917.
Sources: ESRI Digital Chart of the World (1993), Gilbert (1972), Stephan (1994).

became common in Primorye, making life difficult for the sparsely settled newcomers (Stephan, 1994, 54).

3.2.2 1870-1896

In-river harvests were likely quite significant, as Cossack border settlements and peasant towns were founded at native village sites, near prime salmon spawning grounds. By the 1870s, there was a good deal of local trade in salmon, with markets in larger towns, at military garrisons and in the gold fields in the middle reaches of the Amur River (Eniutina, 1974; Malozemoff, 1958).

The first fisheries regulations in the Russian Far East were a result of the Russo-Japanese Treaty of St. Petersburg (1875). The treaty awarded Sakhalin Island to Russia, and the central and northern Kuriles to Japan. It also granted Japanese fishers access to Russian fisheries all along the Far East. Implementing regulations provided free access to Russian fishermen, and charged a poundage fee to Japanese harvesters (Mandrik, 1994, 41). Enforcement of the harvest tariff was spotty at best (Mandrik, 1994, 154). Japanese treaty access to Russian waters was a blow to the struggling Russian fishery, as it eliminated the need for Japan to buy from Russian harvesters and traders (Malozemoff, 1958, 8).

The Primorye Governor Generalship was established in 1884 at present-day Khabarovsk on the Amur River, and encompassed all of the present-day Russian Far East (Figure 3.9). The new administration had a riverfront view of the Amur salmon fishery and full jurisdiction over natural resource management.[7] Japanese merchants and fishers appeared in the Amur Sound for the first time in 1892, and suddenly foreign fishing in Russian waters was an obvious problem. Russian fish merchants were just beginning to take hold on the Amur, and had made their first attempt to ship

[7] The Governor Generals of Primorye were appointed by and accountable directly to the Tsar, and had extraordinary powers. They levied taxes, administered justice, enacted laws, controlled the police force, and conducted foreign policy on behalf of the tsar (Stephan, 1994, 55). The Governor General of Primorye was also delegated authority for natural resource management. All natural resources were owned by the government, and fell under the purview of the Ministry of the Government Domain (Mandrik, personal communication).

salmon to Siberia that same year (Eniutina, 1974). Governor General Korf imposed the first Primorye fishery law in 1894, with the intent to limit foreign fishing (Mandrik, 1994).

At the national level, fisheries specialists were beginning to develop a professional identity. The Russian Society for Fish Breeding and Fishing was formed in 1881, with the approval of the Ministry of the Government Domain. The organization persisted through 1917, organizing conferences, research programs, and lobbying for a national law on fisheries (Borisov, 1964, 29).

3.2.3 1897-1914

In approximately 1898, Governor General Korf created a special Primorye Division of the Ministry of the Government Domain to manage fisheries in the Russian Far East (Mandrik, 1994; Vakhrin, 1996a). Most of the attention of the Primorye Division was focused on the Amur River salmon fishery. It was a high volume, terminal fishery conducted within a day's journey from Khabarovsk, and at the turn of the century it generated up to 70% of Russian Far East fisheries harvests. Sakhalin was close enough that it also received special attention. The Division did not have any sense of the fisheries' wealth of the remote Kamchatka peninsula and Sea of Okhotsk, and only reluctantly leased fishing concessions in those areas (Mandrik, 1994, 52).

The Primorye Division proclaimed a series of temporary fishery laws between 1899 and 1901, which were contradictory to one another. The 1899 law legalized the use of foreign labor everywhere but in the Amur fisheries. The following year, a temporary fishery law was proclaimed specific to the Amur River. A 1901 law once again forbade foreign labor in harvesting and processing, except for certain concessions on southern Sakhalin (Mandrik, 1994, 42, 66, 158). The exclusion of southern Sakhalin concessions was a de facto acknowledgement of the traditional Japanese fisheries in that region. The 1901 also law created a set of concession or lease categories that remained in use for the next two decades (Chapters 6 and 8).

The new concession system fostered a degree of certainty in the Amur and northern Sakhalin fisheries, and increased non-Japanese investment (Mandrik, 1994, 47-48). The Amur and Sakhalin fisheries were now a mixture of commercial ventures and local peasant and subsistence fisheries. Transportation was limited to waterways and wagon roads. Local markets, including gold fields, military garrisons, and cities (e.g., Khabarovsk and Vladivostok), were not large. Japan was the biggest market, buying dry-salted fish and fish rendered into fertilizer. The lack of a local labor force and domestic sources of investment were major obstacles to the development of the Amur River fishery.

Amur River harvests increased steadily in the 1890s and 1900s, and expanded rapidly after the Russo-Japanese War (1904-1905; Figures 3.10, 3.11). The Russian-operated Chinese Eastern Railway began service from Vladivostok to Moscow and St. Petersburg in 1903, considerably decreasing travel times to populous western Russia. Amur salmon was requistioned during the war against Japan to feed Russian soldiers. After the Russo-Japanese War, soldiers returning to the west took with them a taste for Pacific salmon, particularly for salmon caviar. Russian fish merchants developed better processing for caviar in 1908, leading to a more palatable product. The new technique led to new markets in Japan as well (Zolotukhin, mss.).
Foreign fishing in Russian coastal waters was not effectively regulated, because there was only one Vladivostok-based schooner patrolled the entire Russian Far East.

The Russo-Japanese War had major repercussions for salmon allocation. One of the stipulations of the Treaty of St. Petersburg (1907) renewing diplomatic relations was the negotiation of a framework fisheries agreement between the two countries. The Russo-Japanese Fisheries Convention (1907) was also concluded in in St. Petersburg. The Convention delineated Russian-only ("non-Convention") and foreign concession ("Convention") areas throughout the Russian Far East. As before, the Amur River was reserved for Russian peasants, natives and entrepreneurs. Southern Sakhalin (Karafuto) became Japanese territory, and its fisheries were rapidly developed by Japanese pound-trap operators and gillnetters (Figure 3.9). The

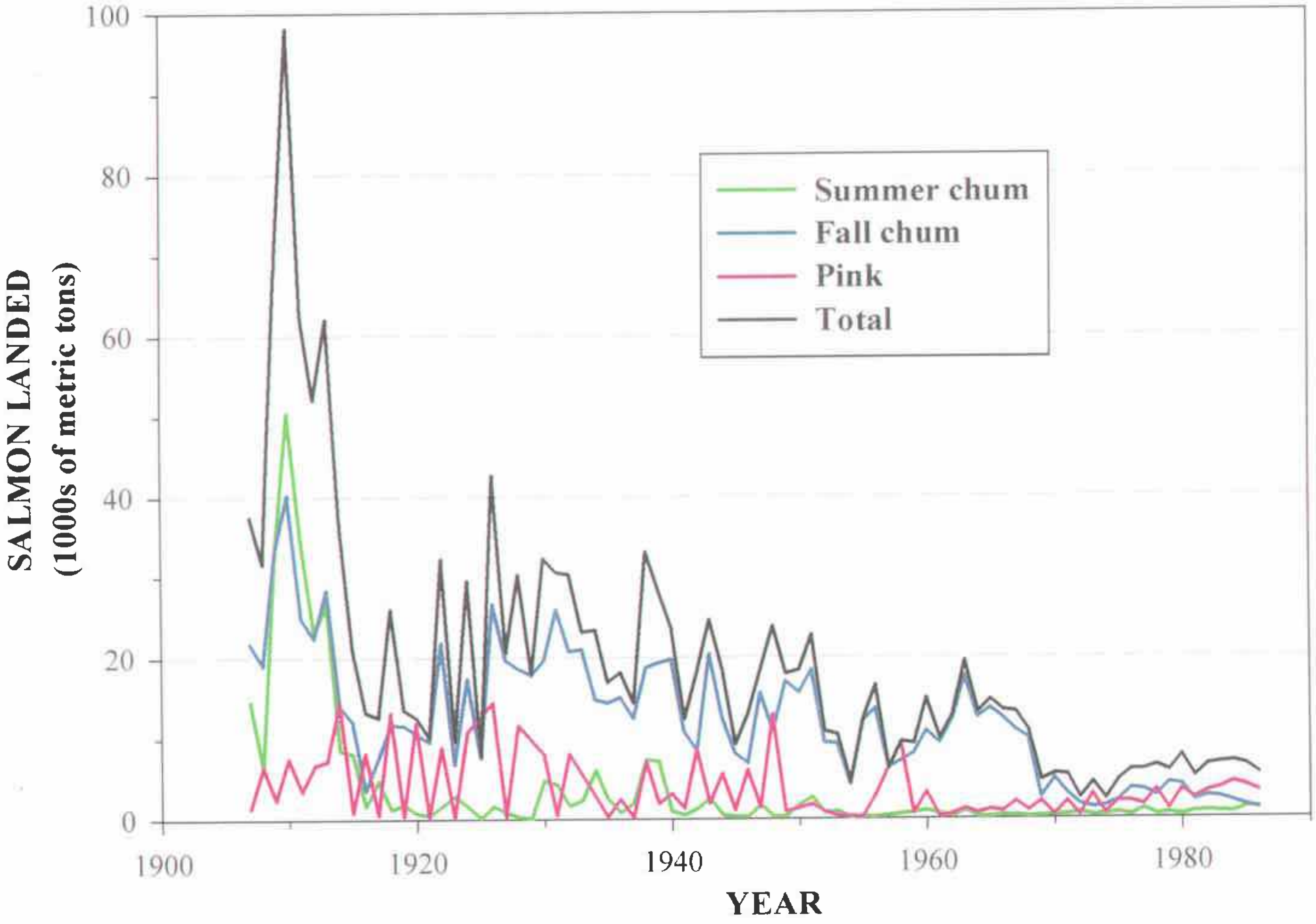

Figure 3.10. Amur River commercial salmon harvests, 1907-1986, in thousands of metric tons. Source: Ianovskaia et al. (1989).

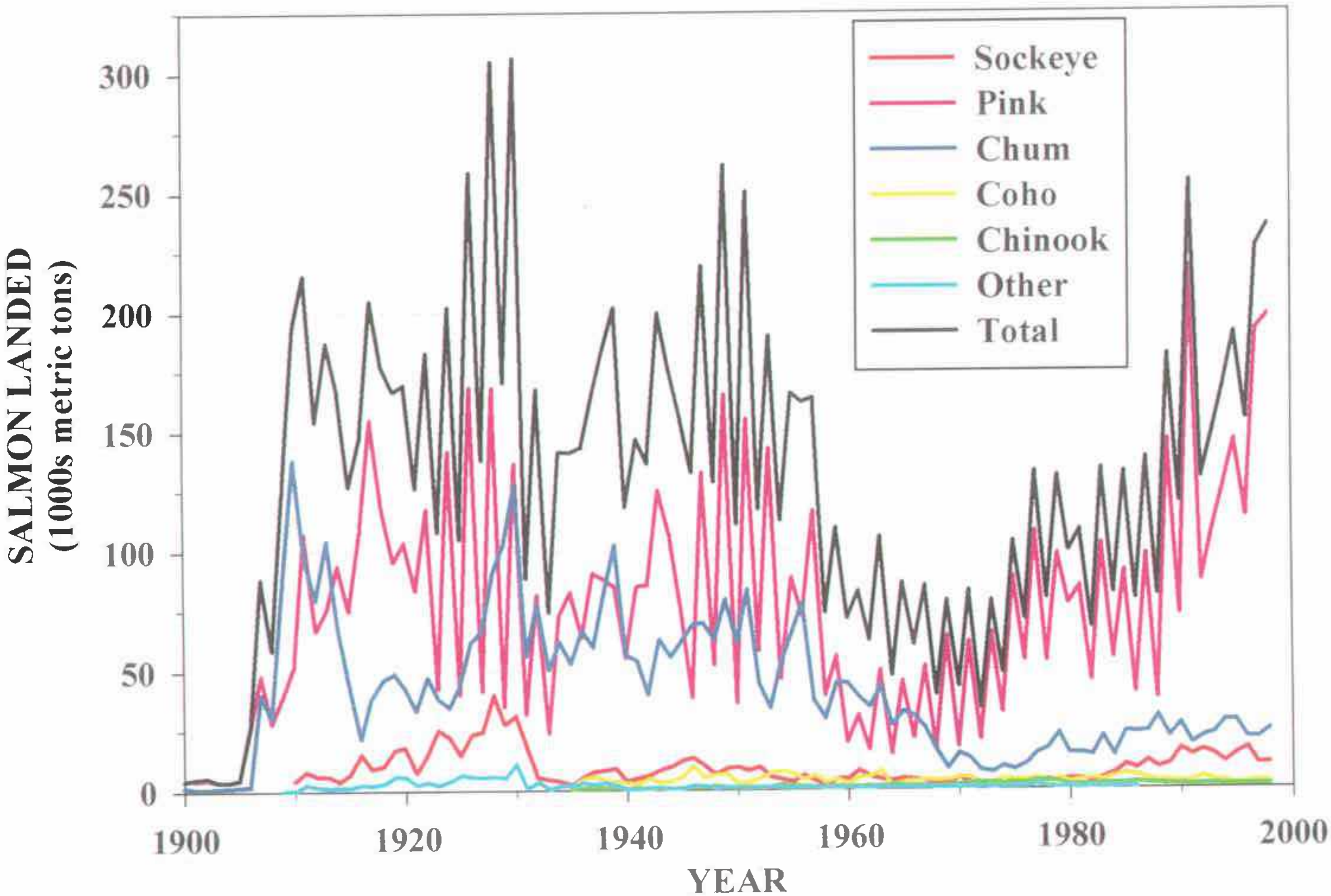

Figure 3.11. Russian Far East commercial salmon harvests, 1900-1998, in thousands of metric tons. Sources: Ianovskaia et al. (1989), Rogers (1999).

Kamchatka Peninsula became the center of Convention waters and the Japanese shore-based fishery in Russia.

Salmon harvests in the Amur River basin exceeded those on the Kamchatka Peninsula until 1909 (Figure 3.11). Between 1910 and 1914, the Amur and Kamchatka regions produced almost the same total amount of fish (including Convention and non-Convention waters), accounting for 45.6% and 46.5% of Russian Far Eastern harvests, respectively (Mandrik, 1994, 50, 86). The following year, the center of salmon production shifted to western Kamchatka.[8] Far Eastern fisheries harvests were still minor relative to harvests in the Caspian Sea (10.6% vs. 65.1% of national harvests) (Borisov, 1964, 6).[9]

Russian officials and entrepreneurs began to experiment with hatcheries during this period, although stock declines were not yet evident. The first Russian salmon hatchery appeared on a small tributary of the lower Amur River in 1909. Funded by the Department of Agriculture, it had earlier been the site of a private fish breeding station, experimenting with chum and pink salmon fry (Borisov, 1964).

Russian fisheries policy during this era appeared to be to maximize revenues from leases in Convention waters, and to preserve a monopoly for small-scale Russian fisheries in rivers and closed bays. Russia still had no comprehensive fisheries law, and the need for legislation was hotly debated during the Third All-Russian Congress of the Fish Breeders and Fishing Society in 1910. The lack of government credit for the Far Eastern fishing industry was a major issue, and members of the Society lobbied the government for aid in order to slow Japanese fisheries expansion (Borisov, 1964, 30-31). The only government action was to give chum and pink salmon transported by rail a 25% tariff break, drawing up to 80% of all Far Eastern salmon harvests from

[8] The shift of the salmon industry from the Amur River to Kamchatka can be seen in Figure 3.11 as a shift from a chum-dominated harvest (Amur) to a pink and sockeye-dominated harvest (Kamchatka, secondarily Sakhalin).

[9] Salmon comprised more than 90% by volume of Russian Far Eastern fish harvests through the end of the Russian Civil War in 1922, with herring in second place (Baievsky, 1926) 46-47.

non-Convention and peasant leases to markets in European Russia (Baievsky, 1926; Mandrik, 1994).

3.2.4 1915-1946

Japanese harvests in Russian waters continued to grow throughout WWI and the interwar period. The Tsarist Government dropped restrictions on foreign labor in the fisheries during WWI, and Russian-based Japanese producers became the principal suppliers of canned salmon on the world market (Mandrik, 1994, 64-65). Japanese-held salmon concessions were now a major source of government income (Mandrik, 1994, 58). The Russian fishing industry in Nikolaevsk-na-Amure and Vladivostok was maturing, and Japanese companies were beginning to worry about the erosion of the Russo-Japanese Fisheries Convention. An association called Roryo ge ge kenhojen domeikai was formed to lobby for favorable Russian fisheries laws. In 1914, the fishing industry formed Nichiro Gyo Gyo Kabasuki Kaisha, an conglomerate of harvesters and processors operating in Russian waters. The members of the conglomerate included three-fourths of the Japanese operating in Russian waters, and harvested 85-90% of the catch (Mandrik, 1994, 164-166).

The Russian fishing industry struggled during WWI because of shortages of labor and fuel and declining Amur salmon runs (Figure 3.10). The Japanese again took over the fisheries, as labor laws were suspended because of the war effort. The Priamurye Governor Generalship ceased to exist in March of 1917, and soviets and public safety committees took its place (Stephan, 1994, 306). Fisheries formally fell under the new Peoples's Commissariat of Agriculture (Narkomzem), which attempted to immediately nationalize the industry. A period of chaos ensued as the Russian Revolution unfolded. All but one of Russia's fishing regions were under the control of either foreign interventionist armies or White Guards (Russians opposed to the 1917 socialist revolution). In most cases, the existing fish merchants simply formed new partnerships with the emerging authorities and attempted to carry on business as usual (Mandrik, 1994, 68; Zolotukhin et al., 1997).

The Japanese occupied Vladivostok early in 1918, seized the Chinese Eastern Railway and established their occupation headquarters east of Lake Baikal. Most of the Civil War (1918-1922) was fought along the railways, destroying most of the newly completed Trans-Siberian railroad. The Bolsheviks ousted the intervention forces and created the Far Eastern Republic (FER) in 1920. The FER was a puppet regime, created to appease independent-minded Russian Far Easterners and attempt to negotiate them into the newly formed socialist republic. Upon the creation of the FER, Japanese forces withdrew to the Lower Amur and Ussuri River regions (Figure 3.9). The period from March 1917 through November 1922 was one of near anarchy in the Russian Far East, with a series of more than eleven governments representing various political factions in existence at Vladivostok and Khabarovsk, each claiming control over the entire Russian Far East (Stephan, 1994).

New fisheries management agencies were created every few months in Vladivostok and Khabarovsk, along with the various revolutionary governments. Each of the new agencies battled the others, in an attempt to control the regional fishing industry (Mandrik, 1994, 75-76). The Japanese Military Governor took over direct administration of the Amur River and Sakhalin fisheries by 1920, including responsibility for concession auctions. The Military Governor also announced an unrestricted fishery in the Sea of Okhotsk and the waters off Kamchatka (Mandrik, 1994, 74).

With the advent of the Far East Republic in 1920, fighting slowed in all but the southern Russian Far East, including Vladivostok. The FER created a Division of Fishing and Hunting, with territorial enforcement units in most of the provinces (oblasts) of the Far East (Mandrik, 1994, 99). In 1921, the Republic passed a resolution entitled "Regulations and terms of trade on concessions along the shores of the FER", proclaiming the White Guard Kolchak extension of the 1907 Russo-Japanese Fisheries Convention null and void. The Japanese Occupation ignored the proclamation and retained control over the fisheries by continuing to thwart the Volunteer Fleet and negotiating with rebel governments in Vladivostok (Mandrik, 1994, 80-84). The fishery was Russian on paper, but almost all of the concessions were sublet or directly operated by the Japanese (Vakhrin, 1996a, 85).

The Soviet authorities in Moscow created the Central Fisheries Agency (Glavryba) as an interministerial body to manage and execute fisheries in 1918. The new organization was based in the Provisions Ministry (Narkomprod). Glavryba was to resurrect the fishing industry, produce as much fish as possible, protect fish resources, and lay the groundwork for a plan-based fishery. Its objectives were virtually impossible to achieve during the Civil War. The Central Fisheries Agency was reorganized the first of many times in 1920, and given authority over applied fisheries science and artificial propagation (Borisov, 1964, 58).

The Soviet government enacted two national decrees in 1921, the first reorganizing fisheries management organizations and the second setting forth a mixed policy of fisheries conservation and development based on a combination of nationalized companies and private capital. A dual system was created, whereby companies in nationally significant fisheries were to be nationalized on an opportunistic basis, with fishing rights leased on a preferential basis to government enterprises, followed by cooperatives, public-private partnerships and lastly, to private companies (Mandrik, 1994, 118). Fish could be sold freely on the private market, and private capital persisted. This approach was typical of the New Economic Policy (1921-28), which sought to encourage reconstruction of infrastructure, labor training and the production of basic foods using a mixture of private and public capital (Vakhrin, 1996a, 85; Mandrik, 1994, 95-96).

The Japanese, French and US interventionists left Vladivostok in October 1922, ending the Civil War. The Far Eastern Republic was incorporated into Soviet Russia the following month, but most of the legal and organizational structure was retained for an interim period by the new Far East Governorship (Dalnevostochnaia Guberniya; the boundaries were approximately the same as those of the Priamurye Governor-Generalship, Figure 3.9). The new government was moved to Khabarovsk in 1923 and Soviet rule was extended around the shores of the Sea of Okhotsk and to Kamchatka. By the end of 1924, the Soviets had retaken control of Chukotka and

Wrangel Island. In 1926, the Far Eastern government was renamed Dalnevostochnyi krai, or Dalkrai, and contained the Amur, Khabarovsk, Primorye, Kamchatka, and North Sakhalin provinces, plus the Chinese Eastern Railway zone (Stephan, 1994, 184). Provincial boundaries have remained relatively constant through the present (Figure 3.12).

The leading Communist Party committee in the Far East, Dalrevkom, created a Fisheries and Hunting regulatory agency situated in Vladivostok, with branches in the district capitals of Blagoveshchensk, Khabarovsk and Nikolaevsk (all within the Amur basin; Figure 3.9). The new Fisheries and Hunting regulatory agency worked alongside the Federal Russian Far East Fishing Agency (Dalryba), in charge of fish harvesting in the Russian Far East. The federal Provisions Ministry abolished the Vladivostok Fishing and Hunting agency the following year, creating a new entity called the Far East Fishing and Hunting Agency (Dalrybokhota). The new agency was to report to the Central Fishing Agency (Glavryba) in Moscow. Its objectives were to assert control over Far Eastern fisheries, minimize Japanese fisheries expansion, and support the Russian private sector fishery. Dalrybokhota had authority over all fisheries, hunting and trapping in the Russian Far East, which was subdivided into ten marine regions (Mandrik, 1994, 99-101).

Smirnov (1961) dates the beginning of Soviet fisheries management on the Amur River to 1924. The basic management structure was established by the decree "On the organization of fisheries management of the Socialist Russia" in 1922 (Kolbasov, 1974, 38). The Pacific Science Station was established in 1924 in Vladivostok, in affiliation with the Far East Fishing Agency. The new laboratory, the precursor to TINRO (Pacific Institute for Fisheries and Oceanographic Research), was founded by the Far East Revolutionary Committee of the Communist Party (Dalrevkom) in order to put fisheries on a "scientific basis" (TINRO-Centre). Beginning with the Amur fisheries in 1924, a system of catch quotas, fishery closures, spawning ground protection and artificial propagation was adopted (Smirnov, 1961, 77). Spawning surveys were undertaken beginning in approximately 1925, but they were not conducted systematically at the time (Zolotukhin and Semenchenko, 1992).

Figure 3.12. Present Russian Far Eastern provincial and territorial administrative boundaries. Source: ESRI Digital Chart of the World (1993) and the Washington State Geospatial Data Archive.

Regional fisheries vocational schools were established shortly thereafter to train fisheries professionals (e.g., Dalrybvtuz (1930) in Vladivostok; Borisov, 1964; Ivankov, 1997).

Fisheries were nationalized and collectivized beginning with the First Five Year Plan in 1928. The emphasis in the fishing industry was on producing as much protein food as possible for the internal market. Russian Far East harvests climbed steadily from 1928-30, because of increasing fishing effort, extended fishing areas, improved infrastructure and guaranteed markets (Figure 3.11). The Amur fishery, however, declined after achieving a secondary peak in 1926 (Figure 3.10; Ianovskaia, 1989).

Systematic production plan targets were introduced in 1932 and immediately began to undermine the new, scientifically based fisheries management system. Plan targets were perpetually over-optimistic, and the cooperatives and government enterprises could not fulfill them alone. Communist Party officials at the territorial and district level would enlist hunting collectives and other organizations to help meet plan targets during the fishing season, so as not to fall short (so-called "auxiliary suppliers"). Through the inertia of central planning, quota targets were increased each year without accounting for biological limitations upon fish production. Harvests declined across the Russian Far East during the first years of collectivization, on the Amur between 1932-1937 and across the Far East between 1930-1934 (Figures 3.10, 3.11). By analogy to the agricultural sector, it is probable that many private fishing companies destroyed their infrastructure rather than turn it over to the Soviet government. The predominant gear types in the Russian fisheries were, as in pre-revolutionary times, net traps and beach seines, updated with the use of mechanical or electrical winches (Zolotukhin et al., 1997).

In 1932, regional regulations "Regarding fishing and marine resource extraction in the Pacific Ocean waters of the USSR" were promulgated (Vakhrin, 1996a, 127). At the ministerial level, fisheries jurisdiction was shifted at least three times during the stormy decade of Stalinist purges. In 1935, the government issued new fisheries policy, entitled a "Proclamation regarding the regulation of fishing and the protection of fish stocks". No implementing norms or regulations were ever developed, and the policy was rescinded completely in 1942 because of the war effort (Zolotukhin et al., 1997).[10]

All fisheries regulations were set aside during World War II, and all types of economic and social organizations were sanctioned to fish in order to feed their workers (Zolotukhin et al., 1997). It is difficult to discern a clear trend in Russian Far Eastern harvest levels after Hitler began his march across Europe in 1939, or after the invasion of the Soviet Union in 1941 (Figure 3.11). It is likely that true harvests during this period were much higher than official statistics indicate, particularly on the heavily populated Amur River, because no data was collected from non-fishing enterprises or from individual harvesters during the war (Zolotukhin et al., 1997, 63). Rybvods, the territorial branches of the Federal Fisheries Conservation, Enhancement and Enforcement Agency (Glavrybvod), were opened on Kamchatka and Sakhalin in 1946, in the aftermath of WWII. The Rybvods are the principal monitoring, enforcement and hatchery production organizations to in the territories, analogous to regions of the US National Marine Fisheries Service (Figure 3.13). Fisheries on northern Sakhalin and Kamchatka had previously been managed from Amurrybvod (Khabarovsk) and Primorrybvod (Vladivostok).

Stock forecasting and annual quota development is the responsibility of the Pacific Institute for Fisheries and Oceanographic Research (TINRO) and its Moscow overseer, the All-Russian Institute for Fisheries and Oceanographic Research (GlavNIRO). The Federal Fisheries Conservation, Enhancement and Enforcement

[10] I was unable to locate a substantive summary of the content of either the federal decree or the regional regulations.

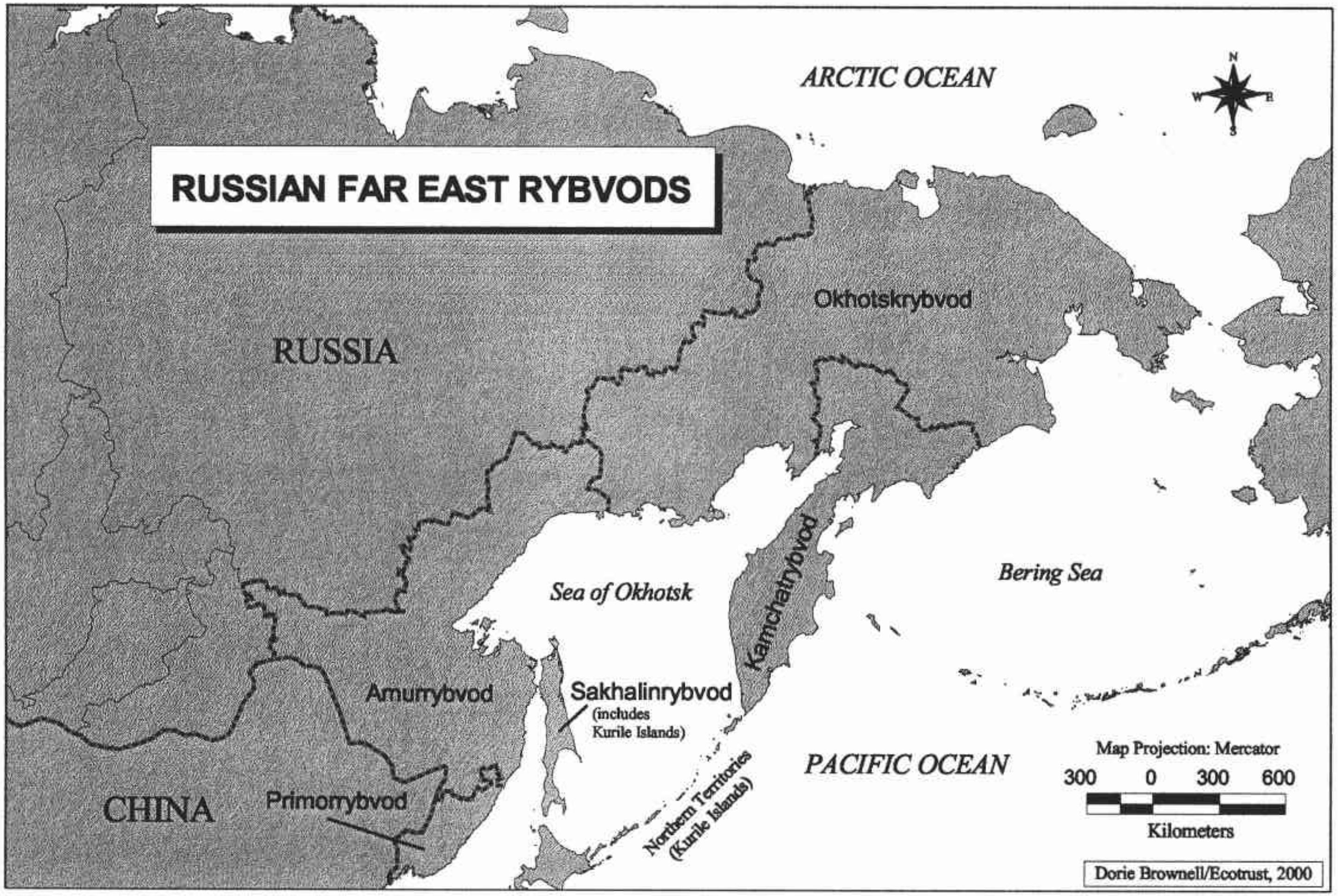

Figure 3.13. Russian Far East Territorial Divisions of the Federal Fisheries Conservation, Enhancement and Enforcement Agency (Rybvods). Source: Pacific Rim Project, S. Zolotukhin.

Agency (Glavrybvod) and GlavNIRO were housed jointly in the Ministry of the Fishing Industry in 1949, and in a series of other ministries and government bodies in subsequent years.[11]

3.2.5 1947-1975

Russian Far Eastern salmon harvests show a small increase between 1947-1953 (Figure 3.11). Official statistics probably reflect Soviet harvests in what had previously been Japanese fisheries on southern Sakhalin Island (Karafuto) and the Kurile Islands (Shepard et al., 1985b, 13). Driven by a shift in the abundance of pink and chum salmon, Russian Far Eastern harvests began a precipitous decline in approximately 1954 and remained low through 1975 (Figure 3.11). Reviewing Japanese and Russian catch statistics, it is clear that Japanese interception fisheries for pink and chum salmon were part of the reason for the decline. The harvest record for pink salmon provides the best evidence for this conjecture, because Japanese domestic production of pink salmon is very low, but pink salmon harvests between 1954 and 1976 were substantial (Figures 3.5, 3.6; Shepard, 1985, 13).

Numerous policy changes were implemented in response to the decline in Russian Far Eastern salmon harvests. The Seven-Year Economic Plan (1959-1965) brought about dramatic economic restructuring in the fisheries: salmon processors and canneries were closed down and many fish harvest collectives were either eliminated or relocated to focus on marine fisheries. Kamchatka fishing collectives took delivery of their first trawlers and began harvesting fish other than salmon and herring. Government fishing enterprises Primorrybprom and Sakhalinrybprom also began trawling off of Kamchatka during this period (Figure 3.12). By the late 1950s, Soviet trawlers were equipped with fish-finding equipment and radar navigation, enabling them to travel greater distances and more efficiently locate aggregations of fish (Vakhrin, 1996a, 132; Vakhrin, 1996c, 33-34).

[11] Between 1918 and 1993, fisheries management and applied research functions were reorganized and/or shifted between ministries, committees, and subdivisions of the Soviet planning apparatus (Gosplan) twenty four times (Zolotukhin, 1996a). This pace has not abated since the collapse of the Soviet Union, with at least three changes in name and status since 1993.

Declining Pacific salmon resources also led to legal changes. A framework fisheries law was decreed in 1958. The new fisheries law, "On the conservation of fishery resources and the regulation of fishing in waters of the USSR," was the last comprehensive piece of fisheries legislation promulgated by the Soviet Union. It created a framework for fisheries management, specifying the types of regulations that could be developed by the regional Fisheries Conservation, Enhancement and Enforcement Agencies, or rybvods. The Rybvods were given review authority over a variety of competing water uses, water quality, and forest practices that might affect salmon spawning habitat. The decree was implemented by a series of regional regulations, tailored to large economic regions such as the Russian Far East. The implementing rules for the Russian Far East fisheries under this decree were not promulgated by the Ministry of Fisheries until 1980 (Volkov and Bekiashev, 1980, 83; Kolbasov, 1974, 40).

In the late 1950s, salmon harvest was prohibited to all but juridical persons. All harvest on spawning tributaries was prohibited, aside from small native quotas of 50 kg/person/year (Zolotukhin et al., 1997). The main effect of the prohibition was to create a shadow fishery, initially consisting of individual poachers, and eventually including networks of harvesters and illegal salmon and roe processing workshops. The illegal fishery was facilitated by the production of an inexpensive and reliable Soviet outboard engine (Vikhr) and the advent on the black market of Japanese monofilament gillnets in the 1960s. The Vikhr converted any small boat into an effective fishing boat. Monofilament nets did not require open-air drying as did previous cotton or hemp nets (conspicuous and time-consuming), required less repair, and were much easier to hide because of their compactness. The management consequence was a loss of information regarding the true levels of harvest and effort in the salmon fisheries, particularly near major population centers (Zolotukhin, 1996b). It is possible that a component of the apparent decline in Russian Far Eastern fisheries can be ascribed to unofficial harvests (Figure 3.11), but poaching pressure was significant only near a handful of major urban areas; e.g., Khabarovsk, Komsomolsk-na-Amure, Petropavlovsk, Yuzhno-Sakhalinsk (Figure 3.12).

Perhaps in acknowledgment of the increased level of illegal harvests, the Council of Ministers issued the decree "On measures to strengthen conservation of fish stocks in waters of the USSR" in 1969. The decree established a system of fines for civil infractions of fishing regulations and destruction of fish habitat, and provided for criminal prosecution if warranted. The law also prohibited individuals from selling certain species of fish (Kolbasov, 1974, 42). Any fines levied were to be split 30%-70% between the local inspectorate bonus fund within the regional rybvod, and the Ministry of Fisheries budget. Monetary damages awarded as mitigation for destruction of fish or fish habitat were to accrue to the rybvods for fisheries management (Volkov and Bekiashev, 1980, 97). In practice, it is nearly impossible to levy criminal penalties for fishing violations or destruction of fish and fish habitat. The legal standard for a criminal, versus a civil penalty requires that the infraction in question "inflicted serious ecological damage causing the depletion of resources" (Anonymous, 1997, 6). This burden of proof is virtually impossible to establish in the case of any single incident of overfishing or poaching, rendering the laws ineffective.

Run forecasting became a major focus of salmon researchers in the regional divisions of TINRO by the 1970s, as a key component in the process of developing total allowable catch (TAC) recommendations for the economic planning process. TINRO's forecasting role was formalized in 1971, when salmon run forecasts were first assembled in a Ministry of Fisheries document and published in book form, for internal use only.[12] Run forecasts are made at the scale of major commercial harvest area by species and race, and usually reflect aggregate production from several streams or river systems. Forecasts and TAC recommendations are made to Moscow two years in advance (e.g., in October 1979 for the September 1981 fall chum salmon run on the Amur River), and the following spring are handed back down as approved catch quotas. Japanese allocations under the USSR-Japan Fisheries Agreement were decided in Moscow, while Communist Party officials in the regional administrative

[12] The annual volume is entitled "Kharakteristika sostoianiia zapasov osnovnykh promyslovykh ob"ektov Dal'nevostochnogo Basseina v 19xx g. i prognoz vozmozhnykh ulovov na 19xx+2 g., and is published in Vladivostok after confirmation in Moscow.

centers of the Russian Far East allocated the remainder. Prior to the early 1970s, forecasts were taken as guidance, with economic plan targets dominant. Enforcement of biologically-based quotas in the commercial fisheries improved in the 1970s, but illegal harvests continued to grow, particularly on densely populated rivers such as the Amur (Zolotukhin et al., 1997).

3.2.6 1976-2000

The level of undocumented illegal harvest pressure in salmon fisheries was indirectly acknowledged by the authorization of non-commercial, individual fisheries in the Council of Ministers 1976 decree "On the regularization of sport and hobby fishing." "Sports fisheries" is a misnomer; these fisheries are conducted primarily for subsistence, not for recreation. Fish other than Pacific salmon and other commercial fishery targets can be harvested by children up to 16 years of age without a license. Thereafter, Russian citizens are subject to federal and regional fisheries regulations. For a token annual fee, an individual can become a member of the local or territorial Hunters' and Fishermen's Society. Membership allows fishers to take twice the non-member daily catch limit. Fishers can legally transport two-day's worth of fish away from the harvest location (Zolotukhin, 2000). Salmonid species such as lenok and grayling are managed under this regime, with little to no scientific underpinning for daily limits and catch area designations (Zolotukhin et al., 1997).

In addition to individual fisheries with spinning gear, the new law created licensed fisheries for highly-valued, federally managed species such as salmon and herring. The rybvods were authorized to create licensed individual fisheries if the stocks could support the additional harvest pressure. Implementing rules were to be promulgated by the rybvods, with the approval of the Ministry of Fisheries (Volkov and Bekiashev, 1980, 216-217). The first individual fishery for salmon on the Amur River (drift gillnets) occurred in 1989 (Zolotukhin, 1996b), while on Kamchatka a spinning gear fishery was approved in approximately 1978, and a gillnet fishery in 1984 (Korolyov, 1999a). Although fish are intended to be harvested for individual consumption and not for resale, the individual fishery is for all practical purposes a shadow commercial fishery.

Salmon harvests increased across the Russian Far East beginning in the mid-1970s (Figure 3.11). Recoveries were strongest in the Sakhalin Island pink salmon fisheries, but harvests also increased in west Kamchatka, historically the most important salmon producing area of the Russian Far East. Shepard et al. (1985) note that Kamchatka salmon runs improved only after the Soviet Union extended jurisdiction to 200 nm in 1977, substantially reducing the Japanese interception fishery. Even in the Amur River fishery, which had seen steady declines through 1970, harvests increased somewhat in the mid-1970s (Figure 3.10). Amur River harvest increases may also be attributed to reduced Japanese high seas interceptions. The climate regime shift in approximately 1976 likely played a role as well, by improving marine survival conditions.

In 1980, the Ministry of Fisheries issued "Regulations governing fisheries of internal water bodies of the Far East", creating a comprehensive framework for management of Russian Far Eastern fisheries based on the 1958 Fisheries Law, the 1970 Fundamental Principles of Water Law, the Fishery Conservation Zone Proclamation, and other decrees. The 1980 regulations lay out the range of authority of the rybvods in the region, and a minimal set of requirements regarding fishing gear, seasons, licensing, and enforcement. Although the regulations are tailored to the Far East, some aspects are too specific to be relevant (net mesh size requirements, minimum fish lengths) across all the regions of the Russian Far East. New types of fishing gear are prohibited, unless approved by fisheries authorities. These regulations are still in force in the Russian Far East, as no new comprehensive fisheries law has been passed by the Russian Duma.

Alongside the cyclic upswing in salmon stocks, a new program was developed to reaffirm the status of salmon as an economic resource. A holistic, interdisciplinary program entitled "Losos" (Salmon) was approved by the economic authorities, to be carried out by TINRO, the Academy of Sciences Institute of Marine Biology (Vladivostok) and the rybvods. The program aimed to increase both natural and artificial production of salmon through improved harvest technology, hatchery technology and better forecasting of wild salmon runs. A new Salmon Laboratory was created within TINRO-Centre to further investigate early life history stages of chum and pink salmon, and to improve hatchery technology. The program was not fully funded beyond the first year or two, and plans for additional hatcheries still remain on the drawing board in most regions of the Russian Far East (Glubokovskii, 1989, 3).

However, Sakhalin Island is the exception. Since the collapse of the Soviet Union, Sakhalinrybvod has refurbished its sixteen federal hatcheries and authorized construction of more than seven private hatcheries since 1993, and completely revised its technical protocols for fish culture. Artificial production has a long history on Sakhalin Island, dating to the Japanese occupation of southern Sakhalin. Twenty two Japanese hatcheries were operating on southern Sakhalin prior to the end of WWII (Zhul'kov, 1999). The most abundant species in Sakhalin is pink salmon, and it is the primary output of Sakhalin's hatcheries. According to Sakhalinrybvod, Sakhalin hatcheries have achieved very high rates of return for pink salmon in the 1990s (Liubaeva, 1999).

Boris Yeltsin came to power in August, 1991, after a coup attempt against President Gorbachev toppled the Soviet regime. Communist Party administrative structures were dismantled in 1992, and the current government was established over the succeeding years, through a series of Presidential decrees and the development of a new Russian Constitution in 1993 (Barner-Barry and Hody, 1995).

Post-Soviet fisheries law is fragmentary and largely retains the Soviet framework. The Russian Constitution (Article 71) refers to Russia's jurisdiction over fish resources within its territorial sea, EEZ, and on the continental shelf in accordance with international law. The Constitutional rights to natural resource use, when applied to fisheries, permit anyone under sixteen years of age to fish without a license. Although Russia has not updated its comprehensive fisheries statute since 1958, Russian fisheries law has been elaborated for the Continental Shelf (1995) and the Exclusive Economic Zone (1998). Russian fisheries law is most confusing in the area where most Russian salmon harvests are conducted – within the twelve-mile territorial sea, in rivers and bays. The constituent jurisdictions (krais, oblasts, etc.) of the Russian Federation would like to exert management and fiscal control over near shore and riverine resources, and give preference in quota allocation to local businesses and communities. This is not possible under the current system, with most of the control in federal hands (Magomedov and Parpura, 1998).

The constituent territories have gained a greater role in the quota allocation process. There is now a Russian Far Eastern Salmon Council, which convenes at least twice a year in various locations around the Russian Far East. The Council includes representatives from from GlavNIRO and Glavrybvod in Moscow, the regional TINRO institutes, the regional rybvods, and representatives of the constituent territories. At the fall meeting, oral presentations are made regarding abundance forecasts two years hence, and all forecasts are submitted to TINRO-Centre in Vladivostok for compilation to be forwarded to GlavNIRO and the leadership of the Russian Fisheries Committee (Roskomrybolovstva) for approval. The spring meeting occurs after the Russian Fisheries Committee has concurred with forecasts and apportioned allocations between Moscow (direct foreign quota) and the constituent territories of the Russian Far East. The latter meeting focuses primarily on allocation issues among the constituent territories, particularly for fisheries within Kamchatrybvod and Okhotskrybvod waters traditionally fished by distant-water fleets from Primorye and Sakhalin. Each constituent territory also administers its own Salmon Council, which makes allocation decisions within its territorial boundaries. These responsibilities were previously held by the Communist Party committees at the territorial level. Although the current process is not transparent, it is much more open than the previous system.

The constituent territories have struggled to obtain a greater role in fisheries management within the territorial sea contiguous to their shores. To date, many of the gains are more symbolic than real. The TINRO institutes are all federal entities, reporting to GlavNIRO in Moscow. However, prior to 1992 the Russian Far Eastern institutes reported to TINRO-Centre in Vladivostok, which in turn reported to Moscow. The Sakhalin and Kamchatka institutes now report directly to Moscow, while Magadan, Khabarovsk and the newly created Chukotka institute all continue to report to Vladivostok. Similarly, Primorrybvod in Vladivostok still retains the centralized function of collecting daily and weekly harvest reports from each of the regional branches of the Federal Fisheries Committee, to be forwarded to Moscow. Another indicator of the jurisdictional confusion is the lack of agreement regarding the marine extent of jurisdiction of each of the regional rybvods (Zolotukhin, 1996a; Korolyov, 1999b).

The Russian Federation has attempted to increase its enforcement presence both within its Exclusive Economic Zone and on the high seas. The Soviet Border Patrol was deputized to assist in fisheries enforcement in 1991. In 1998 its successor, the Russian Border Patrol, was given primary authority over fisheries enforcement within the EEZ. Most of the personnel and equipment from the regional rybvods was transferred to a newly created unit in the Soviet Border Patrol analogous to the US Coast Guard. The Soviet Border Patrol is assisted in enforcement by the rybvods, Customs authorities, a branch of the Environmental Protection Committee called the Special Marine Inspection Service, and the police. The rybvods have primary enforcement authority inland, on salmon rivers. Given the number of players, the lack of clear rules, and low to non-existent monthly wages, there is a great deal of room for corruption in the process.

3.3 British Columbia

British Columbia's commercial salmon fisheries began with the opening of the first canneries on the Fraser River in the 1870s.

3.3.1 Pre-1870

Salmon was used both for local consumption and as a trade item between native groups. Fishing sites were generally communally owned, and access was regulated by a senior extended family member. Villages specialized in fishing riverine or marine fishes, and hunting marine or terrestrial mammals, depending on location and access to various food resources (Newell, 1993, 40-45).

As in other regions of the North Pacific, native gear was well-adapted to local fishery (species and physical geography) characteristics. Gear use varied with village location and environment. In tide water, the most common gear types were traps, harpoons, reef nets, and troll gear. Upriver, weirs, traps, nets, harpoons, spears and gaff hooks were commonly used. Only coho and chinook were traditionally caught by trolling, as they are the only species that rise to bait. Traps and weirs were responsible for the highest catch volumes, and were highly adapted to local runs (Newell, 1993, 32-38).

Sockeye salmon, as the oiliest species, has the highest nutritional value and is tastiest when caught in the estuary. Late run chum preserves best, and was thus preferred for drying. Most of the salmon harvested was dried or smoked, and roe was also preserved in various ways (Newell, 1993, 38-39). Pre-colonial aboriginal salmon consumption has been estimated at 220 to 450 kg/person/year, or 900 salmon per family of four per year, varying by location (Newell, 1993, 29-30).[13]

The first British explorer to trade in the region was Captain James Cook, who landed in Nootka Sound in 1778 (Figure 3.14). Spain also laid claim to Nootka Sound, and the two countries resolved their competing claims through negotiation in the 1790s. The crown-chartered North West Company (Alexander Mackenzie, Simon Fraser, David Thompson) was the first to establish trading posts in the territory. The North West Company and Hudson's Bay Company (HBC) merged in 1821. At this

[13] Newell (1993) points out that the weight calculations are based on pink salmon (average weight 1.8 kg across British Columbia). If consumption was biased toward chum (4.6 kg), which she states was preferred for preservation, per capita consumption would be in the vicinity of 1,044 kg/person/year.

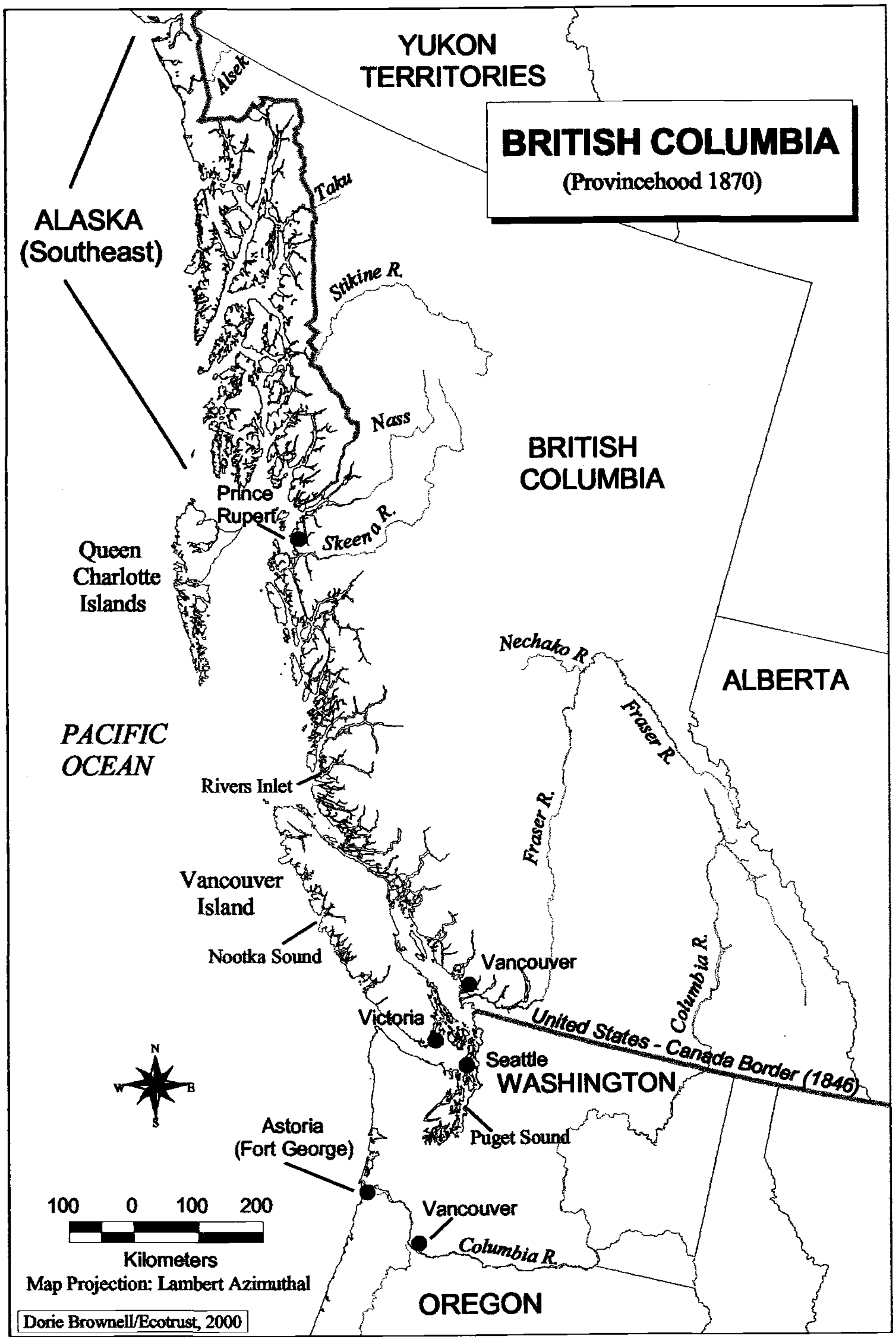

Figure 3.14. The Province of British Columbia, Canada. Source: ESRI Digital Chart of the World (1993); Rand McNally and Company (1985).

time, the united Company had ten trading posts in the Fraser and Columbia River basins. The short-lived Fort George (Astoria, Oregon) was the Company's first coastal post, facilitating ocean transport of furs and other merchandise. Fort Vancouver on the Columbia River was the HBC's principal headquarters until 1846 (Harris, 1997, 37).

The HBC had exclusive Crown license over Indian trade west of the Rockies through 1859 (Lyons, 1969, 65). The Company's fur trade brought Indian tribes into the cash economy through hunting and trapping (Cassidy, 1992). Salmon also became a trade item, as it was the principal foodstuff for the Company's early outposts. HBC's first attempts to export brined salmon from the Columbia River to the Sandwich Islands (Hawaii) in the 1830s were unsuccessful because of spoilage during the long journey (Newell, 1993). Because of its perishability, the salmon trade remained primarily a local activity, while the fur trade was international. The maritime fur trade was in decline by 1825 because of the decline in sea otters and fur seals, and increasing political unrest destabilizing Chinese markets (Gibson, 1992).

The northern boundary of Columbia Territory was resolved by an Anglo-Russian boundary treaty in 1825, driven by the need to clarify hunting territories (Gibson, 1992). Britain and the United States negotiated the Oregon Boundary Treaty in 1846, and the British Canadians retreated north of the 49th parallel (Lyons, 1969, 60-62).

Hudson's Bay Company was the principal authority along British North America's "Mountain Land" (present-day Northwest coast and the interior). In fact, the HBC leased Vancouver Island, and Chief Factor James Douglas administered the Crown Colony of Vancouver for several years while also heading the HBC. With the discovery of gold in the interior in 1858, the Crown Colony of British Columbia was quickly created and Douglas was offered the governorship, on the condition that he resign from the HBC. Douglas administered the three Crown Colonies in the region for several years prior to the establishment of the province of British Columbia (BC) in 1870. One of his first acts upon resignation from the Company and assumption of his new duties was to revoke the exclusive trade rights of the Company vis-à-vis the Indians (Lyons, 1969, 67-68, 74).

The Crown Lands Department established central authority over Dominion fisheries in 1857. The Department's Fisheries Branch had jurisdiction over rivers, fishing leases and licensing. The first comprehensive fisheries legislation in Canada was the Federal Fisheries Act of 1868. The Fisheries Act was passed in response to the depletion of riverine fisheries such as Atlantic salmon, because of overharvest, pollution and passage obstruction by dams associated with mills. The cornerstones of the new law were the creation of a harvest licensing system, provisions against water pollution and passage obstruction, and the promotion of time and area closures and gear regulations to foster biological conservation. Conservation was clearly the primary goal, and leases and license limitations were the basic tools provided to federal fisheries managers to generate conservation incentives (Gough, 1993, 13-15).

In British Columbia, authority was divided over anadromous fish resources and their freshwater habitat from the moment the territory became a province. The British North America (Constitution) Act (1867) distinguishes between "sea coast and inland fisheries" and all other natural resources. Most resource management authority, notably over logging and mining in British Columbia, is assigned to the provinces. Fisheries management was reserved as a federal responsibility, reflecting the vital importance of the Atlantic fishing industry and its role in the founding of Canada (Gough, 1993).

3.3.2 1870-1896

Fisheries laws were not yet in force in British Columbia when the salmon fishery began, although they had already been promulgated for the rest of the Dominion. The first Dominion Fisheries Agent was appointed for British Columbia in 1871 after British Columbia became a province of Canada, but the Fisheries Act did not enter into force in the province until 1877 (Lyons, 1969). The first British Columbia fisheries regulations were promulgated the following year, employing standard language drawn from Atlantic salmon regulations regarding the use of drift gillnets only in brackish or salt water, and limiting the span of fixed nets (Newell, 1993, 48-49).

Canning technology facilitated the development of British Columbia's first commercial fishery on the Fraser River. The market standard for canned salmon in Great Britain, the major export market during this era, was the red-fleshed Columbia River spring chinook. Sockeye salmon were the principal target on the Fraser, as theywere the highest quality red-fleshed fish available in quantity (Muszynski, 1987, 47). The first cannery appeared on the Fraser by 1870, and harvests increased thereafter (Figure 3.15; Lyons, 1969).

Sockeye harvests dominated the Canadian fishery through the early 1900s, although they were already beginning to decline on the Fraser River by the late 1880s (Figure 3.15). It may be that climate-induced variability in salmon abundance was also influencing perceptions of Fraser River harvests during the 1880s and 1990s. Between 1877 and 1891 there were two very strong El Nino events, and three milder events were documented (Quinn and Neal, 1992, 631; see Chapter 4).

Catch limits were imposed on the Fraser River in 1882 in response to the decline, but enforcement was minimal and violations were common (Twitchell, 1989). Additionally, processing companies built canneries in the Skeena and Nass rivers, Rivers and Smith inlets, and in Alert Bay (Figure 3.14), exploiting smaller northern sockeye salmon runs. Artificial production was an intriguing approach to improving sockeye production without curtailing anyone's ability to earn a living, and the first government hatchery was built in 1882 in the Fraser River basin.

Sockeye harvests rebounded on the Fraser River in 1883, resulting in incredible waste because of over harvest and lack of processing capacity. Cold storage facilities were introduced in 1887, extending the salmon processing season (Parsons, 1993, 1). Cold storage facilitated canning company consolidation as it reduced the risk of undercapacity in peaks during the harvest season, or cyclical boom years for sockeye.

Many Indian villages were very involved in the early commercial fishery, particularly in the northern regions. Canneries were frequently located at prime fishing grounds in native villages and cannery and harvesting work became part of the seasonal migration for some upriver bands. Licenses were not required to fish for

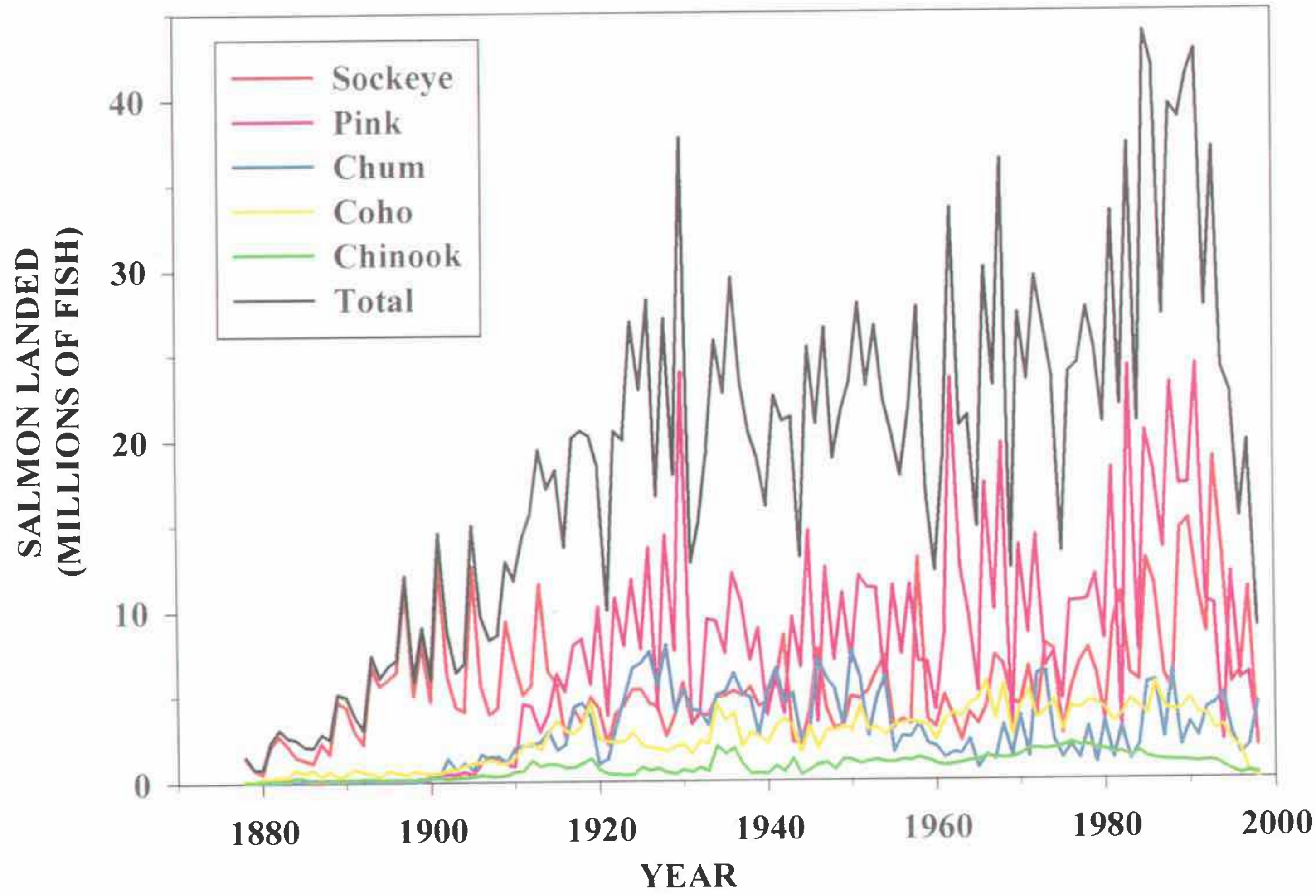

Figure 3.15. British Columbia salmon harvest trends, in millions of fish, 1878-1908. Harvests after 1924 are adjusted to include tribal and recreational catch. Sources: Hare et al. (1999), Shepard et al. (1985a).

salmon until 1888 (Newell, 1989). The canneries initially held most of the fishing licenses (drag- seines, replaced by gillnets), which were issued for particular areas (Newell, 1993, 52-55). Initially, Indian chiefs oversaw drag-seine teams on behalf of the canneries, but eventually family-level Indian-canner relationships became dominant, as long as the Indian harvester made consistent deliveries (Newell, 1993; Pinkerton, 1987, 257). Chinese labor became predominant in the southern canneries, controlled by China bosses from Victoria, BC or San Francisco (Muszynski, 1987, 59-60).

Federal fisheries managers facilitated the growing Pacific salmon fishery by promulgating rules to support the viability of salmon canners, and promoting the rights of independent EuroCanadian and Canadian Indian harvesters. Loan programs and export controls were put in place to support Canadian canners vis-à-vis US competitors. Harvest licenses were limited for a short period between 1888-1892 in all areas, with the majority of the licenses held by the canneries. In support of independent harvesters, traps and drag seines were prohibited in 1894. Although the canners sought to limit fishing areas, seasons and gear used by independent gillnetters, they were unsuccessful (McMullan, 1987b, 108-110).

The first federally appointed commission to investigate fishery regulations in British Columbia was convened in 1890, and the second within two years thereafter. The commission process is the principal means for gathering factual and perceptual information about the fisheries, in order to amend the federal Fisheries Act. The Minister responsible for fisheries appoints commissions composed of specialists, managers and industry representatives to investigate specific aspects of the industry, and to conduct field hearings (Lyons, 1969, 668-669).

3.3.3 1897-1914

Exclusive federal authority over the commercial fisheries was challenged by the provinces in the courts, and led to an 1898 decision conferring provincial authority over property and civil rights pertaining to fisheries on provincial lands (non-tidal portions of rivers), but federal authority over fisheries management. British Columbia rebelled against Dominion control over fisheries by passing the BC Fisheries Act in 1901, claiming property rights to the limits of the 3-mile territorial sea. British Columbia was interested in capturing the revenue stream from licensing and fees, and in administering fisheries regulations within its provincial boundaries. After several years of confusion, federal authority was clarified in 1914 by a Privy Council decision that the provinces never had any property rights in tidewater, thus no jurisdiction over any tidewater fisheries. The only authority delegated to British Columbia was to regulate oyster farming (Parsons, 1993, 22-23).

The 1890s also saw the organization of cannery operators, with a series of associations created with geographically varying membership. By 1902, a united association had been formed that included virtually all of the salmon canning operations in British Columbia. The group was initially known as the Fraser River Canners' Association, but changed its name to the BC Canners' Association in 1909 to better reflect its membership (Lyons, 1969, 671).

Just prior to the turn of the century, the federal government promulgated the General Fishery Regulations for British Columbia (1899), clarifying aspects of the federal law with regard to the unique BC salmon fisheries (Lyons, 1969, 160). There were a variety of technical innovations at the turn of the century, which allowed fishers a greater range of operations. Motors allowed a shift to single-handed harvest, from two person hand-pulled and sail-driven operations. Both Canada and the United States (in Alaska Territory) banned gas motors in gillnet fleets, ostensibly as a conservation strategy (see Chapter 6). Steam or diesel-powered cannery tenders were common by the early 1900s. Artificially produced ice was also introduced at this time, extending the lengths of individual fishing trips and storage time prior to processing. Motors made purse-seine operations much easier, and they also became more common in the BC salmon fisheries (Newell, 1989).

Over half of British Columbia's canneries were built by 1905. Peak sockeye harvests (as calculated based upon canned salmon pack occurred) in 1901, exceeded only by sockeye landings in the late 1980s-early 1990s (Figure 3.15). Canneries began to process other, less highly valued species in order to extend their seasons, and more companies expanded into the northern fisheries. Cannery consolidation reached a peak in 1902, with the new conglomerate BC Packers operating 29 of 48 canneries on the Fraser River, and an additional twelve canneries in the north (Muszynski, 1987, 52). Salmon processing lines were partially automated with the introduction of the iron butcher, eliminating the need for skilled Chinese labor just as this labor pool was diminishing because of exclusionary immigration laws (McMullan, 1987b, 60).

The shift to a broader species mix diversified the gear types used in the salmon fisheries. Purse-seining became more common as markets developed for chum salmon and for herring. The fishery was dominated by Euro-Canadian harvesters, likely because of the cost of the fishing gear and the size of the crew required. Purse seine operators were first required to hold a license in 1903.

Troll gear expanded the seaward boundaries of salmon harvest, because it depends on targeting feeding aggregations of fish rather than schooling return migrations. Trolling expanded rapidly with the rise in cold-storage facilities around 1910, providing coho and chinook for the fresh, frozen, and mild-cured fish markets. The troll fleet was composed of Japanese- and Euro-Canadians. Licenses were not required in the troll fleet until 1917 (Newell, 1993, 73).

Canneries were interested in all means of gaining additional control over harvests to assure operation at full capacity. They lobbied for several years for the reversal of the ban on pound-traps and drag seines, in order to increase control over harvest capacity. A limited reversal occurred in 1904, permitting pound-traps and drag-seines in the Juan de Fuca fisheries, in order to compete with Puget Sound harvesters for Fraser River sockeye (McMullan, 1987b, 109-110). Only two companies took advantage of the exemption, because the gear had high labor and capital requirements. In reality, it was more practical to let independent harvesters bear the risk of investing in fishing gear, given the four-year cycle in Fraser River sockeye abundance (Muszynski, 1987, 54).

In addition, canners retained control of the fishery through the attached license system and license limitation. While canner dissatisfaction had led to the dismantling of limited harvest licensing on the Fraser River in 1892, the canners voluntarily limited the number of harvesters in the Northern region in 1902, 1905 and 1908. A fixed number of harvest licenses was allocated to each cannery, and the licenses were used by Canadian Indian, EuroCanadian and Japanese immigrant fishers working on a share-basis for the canneries. No time and area or volume restrictions were attached to the licenses. This system was formalized for the northern canneries in 1910, with an attached license system, which required canners to provide a certain amount of infrastructure for harvesters and processing laborers in the local vicinity. Increasing EuroCanadian settlement in the northern region forced a change in the system in 1913, with harvest licenses allocated by harvest area rather than by cannery, with a certain proportion designated for independent harvesters (McMullan, 1987b, 109).

Although the independents won this battle, they were denied the use of gas motors in the northern gillnet fleet from 1911 through 1923. Ostensibly a conservation measure, reducing harvest efficiency, the regulation was as much a canner welfare measure as not. The vast majority of gillnet vessels were owned by the canners and operated on a share-basis by harvesters. If any single cannery equipped its fishers with motorized vessels, all the other canneries in the region would be forced to do so in order to compete, driving up their costs and creating excess harvest capacity. Independent harvesters wished to motorize, in order to fish several fisheries consecutively and reduce travel times (McMullan, 1987b, 110-111).

One of the defining events of this period was a railroad construction-related series of rockslides that obstructed passage and altered flow regimes in the Fraser River basin in 1913-14. The effect on sockeye runs in subsequent years was dramatic (Figure 3.15). Provincial and federal authorities and the railroad attempted to remove the obstructions and to develop alternate passage for the salmon runs. The effects of the slides were particularly devastating to Canadian harvesters, because by this time there was a very active American Northwest fishery targeting the Fraser River sockeye runs along their return migration around southern Vancouver Island (Figure 3.14). Canadian diplomatic efforts to gain US cooperation in controlling harvests were unsuccessful, because the United States government had very little leverage to gain Washington State cooperation in conservation efforts (see Chapter 8).

During this period, the nature of the harvesting fleet differed between the southern and northern regions. Independent, Euro-Canadian fishers predominated in the south, fishing year-round in various small boat fisheries. Southern cannery operators preferred this system because it reduced their outlays, given the four-year cycle of sockeye salmon variability. Northern operations relied predominantly on share-based fisheries, with cannery owned vessels operated by either employees or harvesters in long-term debt relationships with the canneries. Japanese immigrants predominated in the northern fisheries, with native and EuroCanadians playing a smaller role (McMullan, 1987b, 110-111).

3.3.4 1915-1946

WWI increased demand for canned salmon in Canada, and therefore in British Columbia. During the war years (1914-1919), fisheries management was passed from the Department of Marine and Fisheries to the Department of Naval Service (Lyons, 1969, 666). Federal regulators licensed new canneries belonging to existing operators, and increased the number of attached licenses accordingly. Asian fishers took on a greater role in the British Columbia salmon harvest sector, because of war-induced labor shortages. In 1917, the Evans Report asserted that there was too much capital and labor in the fishery (Healey, 1993, 252; Newell, 1993, 75, 100).

By the early 1920s, British Columbia's salmon fisheries were considered fully exploited (Healey, 1993, 248). Several major salmon runs, particularly in the Fraser River basin, were depressed because of a combination of overharvest and habitat degradation, including the Hell's Gate rock slide. During the latter years of WWI, total salmon harvests exceeded 20 million fish/year for the first time (Figure 3.15). Other species, particularly pink salmon, played an increasing part in total landings. Harvests during the remainder of this period fluctuated between 10 million and 37.6 million salmon/year. Low harvests in 1921 are attributed to a glut of canned salmon on the market after WWI, in the face of diminished demand (Figure 3.15).

Two Canadian commissions were named to investigate the Pacific salmon fisheries during and after WWI – the Sanford-Evans Commission (1917) and the Duff

Commission (1922). Pursuant to the Duff Commission Report, the northern boat-rating system and ban on motorized vessels were eliminated and the salmon fisheries were opened more broadly to individual harvesters. Pressure for these changes had accumulated among independent harvesters and accelerated with the return of WWI veterans seeking economic opportunities. Specific licenses were issued for Euro-Canadian, native Canadian and Asian immigrant harvesters, with a reduction in licenses for the latter over time (McMullan, 1987b, 111). The reduction in cannery harvest licenses indirectly reduced the number of Japanese harvesters in the salmon fisheries. The exclusionary policy was short-lived, as it was overruled by the Canadian Supreme Court and the British Privy Council in 1928-29. The judicial ruling also invalidated federal licensing of cannery operations, ruling that federal jurisdiction ceased after fish were landed. British Columbia became the sole cannery licensing authority from that time forward (Newell, 1993, 102).

The number of vessels ("effort") in the salmon fisheries increased during the 1920s, leading to a peak in canned salmon pack in 1930 (Figure 3.15). Between 1923 and 1927, the number of gillnet licenses had increased by 53%, trolling licenses by 99%, and purse-seine licenses by 128% (as cited in Newell, 1993, 100-101). The latter jump was because of the development of herring and pilchard fish meal fisheries, but the spread of purse seine gear also led to an increase in effort on fall chum runs, the staple of the Indian food fishery. Power winches and net rollers dramatically increased the efficiency of purse seine vessels, and they became much more efficient than gillnetters in the salmon fishery. The surge in the purse seine fishery spurred the limitation of purse seines in some areas, and prohibitions in others. The major harvest limitation tool during this period was control over the length of open seasons. However, enforcement was poor and violations were rampant (Newell, 1993, 100-101).

The Depression affected salmon markets and led to further salmon cannery consolidations. Despite diminished salmon landings in 1931 and 1932, softened markets did not significantly reduce total salmon harvests for the remainder of the

Great Depression. Overall, there is no clear long-term trend in salmon landings in British Columbia between 1915 and 1947 (Figure 3.15; Healey, 1993, 248).

Indians harvesters were increasingly excluded from harvesting operations, because gear innovations and regulations made it more expensive to own a boat. Given that Indians were wards of the state, living on reserves, they had no equity to borrow against as did their EuroCanadian counterparts. Indians continued to fish, particularly in the northern fisheries, but they developed long-term debt relationships with the canneries. This situation was favored by canners at the time, as it gave them better control over harvests and prices. Aside from the lack of equity, Indian fishers lacked alternative sources of cash income other than logging. The logging industry did not tend to hire through Indian family networks and did not recognize the need for subsistence fishing time each year, making it a less-favored employer (Pinkerton, 1987, 256-257).

Japanese Canadians were excluded from the salmon fisheries during this period as a matter of federal policy. "Japanese" purse seine vessels licenses were gradually reduced, and vessel owners of Japanese descent were forced to charter their boats to the canneries, for operation by EuroCanadian harvesters. The policy was ended in 1928, due to pressure on the government from Japanese Canadian harvesters and from salmon processors (Newell, 1993, 100-101).

The case that won Japanese Canadian harvesters their rights, *Rex v. Somerville Cannery Co. Ltd.* (1928, confirmed by the London Privy Council 1929), also led to diminished federal authority in British Columbia fisheries. The Canadian Supreme Court ruled that the Province of British Columbia had sole authority over salmon after it was harvested, eliminating federal authority to license fish processors. Federal efforts to control harvest levels thus shifted to the harvest sector, and an increased emphasis on local time, area and gear regulations (Newell, 1993, 102).

Although there had been a de facto delegation of authority to British Columbia to manage riverine fisheries after the passage of the BC Fisheries Act, a formal letter of transmittal was not negotiated until 1938. The province has had official jurisdiction over steelhead, rainbow and cutthroat trout since that time (Otway, 1999).

The combination of soft salmon markets, tight federal budgets and research results demonstrating that artificial propagation of sockeye was no more effective than natural spawning led to the closure of the federal hatchery system in Canada between 1934 and 1937. Fifteen pre-WWI federal hatcheries were in operation at the time, rearing sockeye salmon (Johnstone, 1977). Hatcheries rearing sport fishes (i.e., steelhead) were turned over to the province. Harvesters and processors were not happy with the elimination of the hatchery system (Lyons, 1969, 409).

Salmon canners continued to organize themselves to protect their interests during this period, initially represented by the Canadian Manufacturers Association (1924), later establishing a separate identity as the Salmon Canners Operating Committee (1939) (Lyons, 1969, 671).

World War II once again led to loosened harvest restrictions in the salmon fishery, but harvest levels did not rise appreciably. Conscription of Euro-Canadians and internment of Japanese-Canadians benefited Indian harvesters and cannery workers, who filled the labor gap. Japanese vessels were impounded by the federal government and sold to the canners, who in turn sold them to Indian harvesters over time on favorable terms that kept them tied to specific canneries. Japanese-Canadians first received a vote in Canadian elections in 1948, and were finally allowed to return to British Columbia in 1949, resuming a significant role in the salmon fisheries (Meggs, 1991, 159, 163).

3.3.5 1947-1975

The Department of Fisheries was reorganized in 1949 to implement a broad fisheries development program and to meet treaty obligations under the *Sockeye Salmon Fisheries Convention*. The reorganization included an emphasis on applied biological and socioeconomic research. Catch statistics began to be routinely collected across harvest areas on the basis of fish sales slips in the 1950s. Escapement counts were standardized in index rivers across the province. The new research and monitoring capabilities of the Department of Fisheries allowed it to embark upon a program of escapement-based management, emphasizing adequate escapement prior to allocating a harvestable surplus among fishers. Allocation for the Indian food fishery was second priority, followed by commercial and recreational fisheries. Harvest occurs in reverse order, with the commercial and recreational fishers taking their share first, then in-river Indian food fisheries, prior to salmon reaching the spawning grounds (Healey, 1993, 250-251).

Initially it was possible to monitor run sizes on the basis of weekly catch statistics. However, the size of the fishing fleet, average vessel length, and harvest capacity increased dramatically in the 1950-60s, in response to new technology, good seasons and strong markets (McMullan, 1987b, 122). Commercial harvest capacity quickly developed the potential to harvest an entire run before adequate diagnostic statistics could be collected. Test fisheries were instituted in the vicinity of major commercial fisheries, and institutional arrangements were made for in-season adjustments to harvest quotas and allocations (Healey, 1993, 251).

Various conservation measures were adopted during this period. One was the "surfline", an outer boundary for the seine and gillnet fisheries designed to minimize mixed species and mixed stock harvests (Parsons, 1993, 142). Time and area restrictions became much more draconian, with seasons in some areas reduced to a few days, and multi-year commercial closures in some areas. Regulations in 1956 attempted to limit gear efficiency. Unfortunately, short seasons had the unintended effect of prompting fishers to invest more heavily in their vessels and gear, to improve their odds of catching a lot of fish in a short period of time. Net fisheries were more stringently regulated than troll fisheries, at a time when the unmarred coho, chinook and chum from the troll fleet faced increasing demand on the fresh fish market. The regulations prompted an investment in combination vessels that could troll if gillnetting was prohibited, and vice versa (Newell, 1993, 125-126).

Total harvest levels remained steady from 1947-1975, despite the increasing efficiency of the fleet (Figure 3.15). Central coast pink salmon harvests were the only expanding fishery during the 1960s, but they also contracted during the 1970s (Figure 3.15). Pink salmon accounted for 60% of BC's canned salmon pack in the 1960s. Salmon drag seines were banned in 1967, leaving purse seines, troll gear and drift gill nets as the only remaining commercial gear groups. At the time they were banned, drag seines were operated almost exclusively by Indian commercial fishers (Newell, 1993, 127,133).

Seine vessels were improved again during this period through the development of power blocks and drums, to mechanically hoist and reel seines on and off the boat. The purse seine fishery targets pink, chum and sockeye salmon as they aggregate near shore during their return migration (McMullan, 1987a, 36).

Gillnetters fish in and near the estuaries of the major river systems, also targeting sockeye, chum, and pink salmon (Healey, 1993, 249-250). The major innovation in the gillnet fishery during this period was the introduction of monofilament nylon nets. Multifilament nylon nets, introduced after WWII, were a great labor saver over traditional flax and cotton nets. Monofilament nets extended fishing areas and times, because the single-strand fibers were invisible to salmon even in clear water during daylight hours (McMullan, 1987a, 36). Gillnetters were the largest component of the cannery fleet. More Indian fishers were involved in the gillnet fishery than the other gear groups, particularly in the sockeye and chum fisheries of the northern district. Gillnet vessels are less capital intensive than trollers or seiners, thus more accessible to Indian fishers. Even so, many Indian license holders operated cannery-owned boats, or old, less-efficient boats during this period (Newell, 1993, 135).

The dramatic increase in the number and efficiency of independent harvesters led to public debates regarding limiting entry. Federal authorities empaneled a commission under resource economist Sol Sinclair to study the Pacific salmon and halibut fisheries and recommend a strategy for economic rationalization. The first step toward the creation of a limited entry system was to license all fish harvesters, in 1966. The Davis Plan to limit salmon licenses was introduced in 1968. Although the number of boats in the fishery declined (primarily older boats in the cannery fleets), it is estimated that between 1968 and 1982 the harvest capacity of the fleet doubled or tripled (McMullan, 1987b, 124-126). (See Chapter 6 for further details regarding the assignment of harvest rights).

Federal fisheries authority was moved to the newly created Department of the Environment in 1971, where it resided until 1978. Fisheries jurisdiction had been subject to tussles between the Pacific Region (Victoria) and Ottawa for years, and the level of uncertainty and inconsistency of focus increased at this time. Three different General Directors administered the Pacific Region during this transition, as Ottawa attempted to increase its control. The Department of Fisheries and Oceans (DFO) was created in 1978, promoting the status of fisheries decision-making at a time when the fisheries on both coasts were approaching crisis. Solutions to fisheries management problems were focused at the level of individual harvesters, and regulatory stability was low because decisions were frequently reversed in the face of conflict and political pressure. The increasingly complex patchwork of time and area closures, gear regulations and in-season escapement goals was difficult to enforce, and the relationship between the Department of Fisheries and Oceans and the harvesters became more polarized over time (McMullan, 1987b, 148-149).

Both harvesters and canners lobbied for a salmon enhancement program in the 1960s, because all were interested in increasing the harvestable volume of fish. Harvesters were also concerned with the erosion of spawning and rearing habitat, in quantitative and qualitative terms. The United Fishermen and Allied Workers Union (UFAWU) lobbied for government attention to water pollution and the effects of logging, mining and hydroelectric development on salmon runs, and demanded funds for habitat restoration as well as new hatchery facilities (Meggs, 1991, 187, 204).

A joint Federal-Provincial Salmon Enhancement Program was introduced in 1974 to rehabilitate depressed salmon runs and double Canadian salmon production over the long term. A secondary goal was to incorporate salmon enhancement into regional economic development projects in order to increase Indian involvement and to increase public awareness of salmon conservation issues. Although the program has had some spectacular successes, such as the 70% increase in the Babine Lake sockeye run in the Skeena River basin, it also created new problems. In some areas, hatchery runs probably replaced rather than supplemented wild stocks. Hatchery propagation also created mixed hatchery-wild fisheries, leading to overharvest of the less-abundant wild fish. In-season time and area closures became critical to the achievement of escapement and allocation goals in the mid-1970s (Healey, 1993, 255-56).

The salmon canneries consolidated further, packing various species of fish year-round and handling fresh and frozen fish as well as canned product. Although the total number of processing plants canning salmon remained steady between 1947 and 1975, the oldest remote canneries were closed down, and most new facilities were built along the central coast and in urban areas. Cannery owners renamed and reconfigured their lobbying organization as the Fisheries Association of British Columbia (1951), reflecting their multispecies interests. By the 1970s, the Province appeared to lose interest in the fish processing sector, and turned its attention to the burgeoning freshwater sport fisheries and emerging salmon and shellfish farms (Newell, 1993, 122).

3.3.6 1976-2000

The new Salmon Enhancement Program (SEP) was in full swing by 1977, expending $157.5 million Canadian by 1984 on capital construction and enhancement programs. The program emphasized traditional high-valued commercial species, sockeye and chum salmon, although coho and chinook were also cultured. The program initially showed promising results (McMullan, 1987b, 145-146).
The marine sports fishery for coho and chinook expanded rapidly. Chinook harvests peaked in 1976 at over 2 million salmon/year, and coho harvests remained above 3.5 million fish from the mid-1960s through the 1980s. Increased recreational harvests are included in British Columbia salmon harvest trends (Figure 3.15).

Ocean conditions shifted in approximately 1976, generating conditions favorable for sockeye, pink and chum salmon and less favorable for coho, chinook and steelhead. By the early 1980s (chinook) and the late 1980s (coho) it became evident that several British Columbia wild salmon runs were in decline. Wild coho stocks appeared to be dwindling most rapidly (Slaney et al., 1996). Several administrative measures were put in place in order to better assess the problem and slow the declines. Limits were imposed on how much gear trollers could fish at a time, more harvest areas were closed, and in-season quota adjustments became more common. Mixed stock fisheries (hatchery-wild fish of a single species, multi-species fisheries) were reviewed particularly closely. The federal government required marine sport fishing licenses starting in 1981, in order to gather information regarding the volume of coho and chinook harvested outside the commercial fisheries. The new information led to sports area closures to protect specific coho and chinook runs (Healey, 1993, 261).

The Pearse Commission issued a report in 1982 recommending further reductions of harvest capacity, habitat protection, changes in the Indian food fishery and improvements in monitoring and scientific capacity. However, the harvest limitation proposals and the restructuring of the Indian fisheries were too controversial, and were not adopted. The research and monitoring recommendations were implemented, including the creation of a stock assessment unit within the Pacific Division-DFO. Habitat recommendations were not immediately acted upon (Healey, 1993; Parsons, 1993).

Although the government did not take action in the early 1980s, the processing sector did. A final round of consolidations occurred, leaving B. C. Packers, Ltd. the undisputed giant in the industry. The canneries and processing plants not owned by B. C. Packers were owned primarily by the Canadian Fish Company. Many of the remote northern canneries were purchased and then shut down shortly thereafter, eliminating processing and harvesting jobs in fishing-dependent communities. By 1984, 65% of the processing capacity was either in Vancouver or Prince Rupert. Many harvesters were carrying a great deal of bank debt at the time, resulting from the post license-limitation drive to upgrade vessels in combination with strong runs and prices in the 1970s. Lost fishing opportunities forced many into bankruptcy (McMullan, 1987b, 138-142).

By the late 1970s, technical innovations and increased vessel capacity were straining the traditional allocation system. Historically, salmon quotas had been allocated across commercial gear groups in such a way as to maintain traditional proportions of the harvest, using time and area closures. Fleet mobility had increased, allowing the same number of vessels to fish more openings. Increased average vessel size made fishing possible even in inclement weather. The number of combination gillnet-troll vessels expanded dramatically. Many trollers added on-board freezing capacity, extending their trip times and improving product quality. Trollers also made a variety of innovations to their gear, which allowed them to harvest sockeye and pink salmon effectively in order to stay in business given declining coho and chinook stocks. Declining coho and chinook harvests disproportionately affected trollers thus, in contradiction to the historic allocation principal, trollers were allocated more pink and sockeye salmon in order to maintain the income of the fleet (Parsons, 1993, 141-142).

A proliferation of advisory groups were established in the early 1980s to advise the Department of Fisheries and Oceans regarding quota allocations, given the growing complexity of British Columbia's salmon fisheries and the increasing economic significance of management decisions to individual operators. Salmon abundance was declining just as the diversity of harvesters and treaty obligations increased. The Pacific Salmon Treaty process provided an impetus for a new process, because of the catch ceilings for pink, coho, and chinook. A newly created Commercial Fisheries Industry Council was to advise the Minister of Fisheries regarding the allocation among seiners, gillnetters and trollers, but there was no consensus (Otway, 1999; Parsons, 1993, 141-150).

By 1989, the system was streamlined, leaving seven regional area- and gear-specific salmon advisory committees reporting to the Pacific Region of DFO, and five committees reporting directly to the Minister of Fisheries. The Pacific Resources Council was designed to advise the Minister on matters of long-term Pacific fisheries management and conservation. The Pacific Salmon Commission reports to the Minister regarding US-Canada treaty matters. The other three bodies reporting to the Minister represent the major sectors of the Pacific fishing industry, and provide input primarily regarding allocations: BC Aboriginal Peoples Fisheries Commission, Commercial Fishing Industry Council, and the Sportfish Advisory Board (Parsons, 1993, 470-471). The system is still in a state of flux, with a Pacific Fisheries Board to be in charge of licensing and allocation under debate since 1993 (Otway, 1999).

Conditions appear to have been favorable for British Columbia steelhead stocks in the mid-1980s, and many runs returned in large numbers. Record abundance (since the inception of modern record-keeping in the 1950s) led to an expansion in steelhead fishing and guiding, and stressed the ability of provincial fish managers to manage. British Columbia implemented a "classified waters" policy in 1990 to limit the number of guides and angler-days on the most popular rivers, but steelhead stocks then plunged. Steelhead sports fisheries have added a vocal new constituency to anadromous fish management in British Columbia, considerably complicating harvest management and conservation in some areas (Hooton, 1999; Otway, 1999).

The Canadian Supreme Court again enunciated the primacy of conservation for Canadian fisheries management in the *Sparrow* ruling on Indian fishery rights (1990). Native salmon fisheries are the second priority. Aside from self-policing of capped native commercial fisheries, it is not yet clear to what degree the Department of Fisheries and Oceans will share responsibility for salmon management with First Nations fisheries agencies, particularly for stocks that are fished by other stake-holders outside of Canada's waters (Copes, 1999).

The Mifflin Plan (1996), further curtailing harvest capacity in the salmon fleets, was a tough blow for harvesters at a time of great uncertainty. Federal and provincial treaty negotiations with the First Nations regarding land and resource rights created an opening for extension of aboriginal fishing rights. The Pacific Salmon Treaty (see Chapter 8) had collapsed, and the Department of Fisheries and Oceans (DFO) and the provincial government were disputing Canadian negotiating strategy openly and bitterly in the press. Habitat restoration was a priority, but while jurisdiction was in provincial hands, most of the information and financial resources were held by Pacific Region DFO. The harvesting sector was under ever-increasing economic strain. In this context, the governments of Canada and British Columbia signed a Memorandum of Understanding on fisheries issues. The parties agreed to establish a "feedback process" regarding critical policy issues such as fishing-dependent communities, and industry economic sustainability and habitat through a series of new intergovernmental advisory groups. However, the Department of

Fisheries and Oceans reserves full authority to make final and timely decisions within its jurisdiction over commercial fisheries, treaty negotiations and native fishing rights (B. C. Ministry of Fisheries, 1997).

Contrary to the stated desire to streamline and coordinate management of Pacific salmon, British Columbia split its fisheries staff across two agencies in 1998, by creating the B. C. Ministry of Fisheries. The new Ministry subsumes all of the Victoria-based staff of the Fisheries Program located within the B. C. Ministry of Environment, Lands and Parks (MELP), as well as aquaculture personnel from the B. C. Ministry of Agriculture and Forestry. It is responsible for administering the commercial aquaculture sector in British Columbia, and has an oversight and coordination role with regard to aboriginal affairs and industry development (B. C. Ministry of Fisheries, 1998). The Fisheries Program within MELP is responsible for administering freshwater fisheries programs, including sports licensing, sports fish hatcheries, biological inventories, and an ambitious new habitat initiative under British Columbia's 1997 Fish Protection Act (British Columbia Ministry of Environment, 1999).

The Mifflin Plan was revised and financially augmented in 1998 by Fisheries Minister David Anderson, focusing especially on British Columbia's declining coho salmon runs (Figure 3.15). The new program responded to complaints about the narrowly-focused Mifflin Plan. In addition to tight new restrictions on coho harvests, the program provided additional license buy-back funds, provided large sums for habitat restoration and enhancement, and assistance for fishers and their communities to adjust to the new, precautionary and conservation-based approach (Department of Fisheries and Oceans, 1999b).

3.4 Alaska

After the transfer of Alaska from Russia to the United States, the salmon fisheries were managed by the United States federal government until Alaskan statehood, in 1959.

3.4.1 Pre-1870

As in other regions of the North Pacific, native Alaskans depended to varying degrees on salmon as a staple food. Pre-colonial native harvests have been estimated at 12,000,000 salmon/year, and at 14,850 mt/year (Pennoyer, 1978, 17). The Aleuts, Pacific Gulf Eskimos, and North Alaskan Eskimos were dependent primarily on marine mammals (Figure 3.3). The relative scarcity and interannual variability of foodstuffs meant that they were sparsely settled in small groups near food supplies (Fitzhugh and Crowell, 1988).

The Central Alaskan Eskimos and the Northwest coastal peoples (Tlingit and Haida), in contrast, had access to abundant salmon runs as well as marine and terrestrial animals. The interior Athabaskan peoples were primarily terrestrial hunters, but dried salmon were a critical source of winter sustenance for themselves and their dogs. Native fishers used weirs, harpoons, nets, and traps depending on local river conditions and salmon species (Van Stone, 1988). Wicker weirs and traps were widely used. They were light-weight and easy to remove to allow for periodic escapement and passage of salmon upstream to other tribes (Langdon, 1989, 306-308). As in other regions, the Aleuts, Eskimos and Tlingits suffered heavily from Old World diseases after coming into contact with early explorers and traders (Gibson, 1996, 25-26).

Russian traders and explorers were the first to colonize Alaska, aided by agile Aleut and Kodiak Eskimo marine mammal hunters. The Vitus Bering expedition to Alaska (1741) triggered a rush of Russian trapper-traders (promyshlenniki) to the fur-rich Aleutian Islands. Spain and Great Britain sent several expeditions to Alaskan waters between the 1770s and 1790s to protect territorial claims and to investigate the fur trade. The Russian-American Company (RAC) was chartered by the Tsar in 1799, to give formal stature to Russian claims staked out by the trapper-traders. RAC Director and Governor of Russian America Aleksandr Baranov founded the colonial capital on Sitka Sound the same year (Figure 3.16; Gibson, 1992, 14).

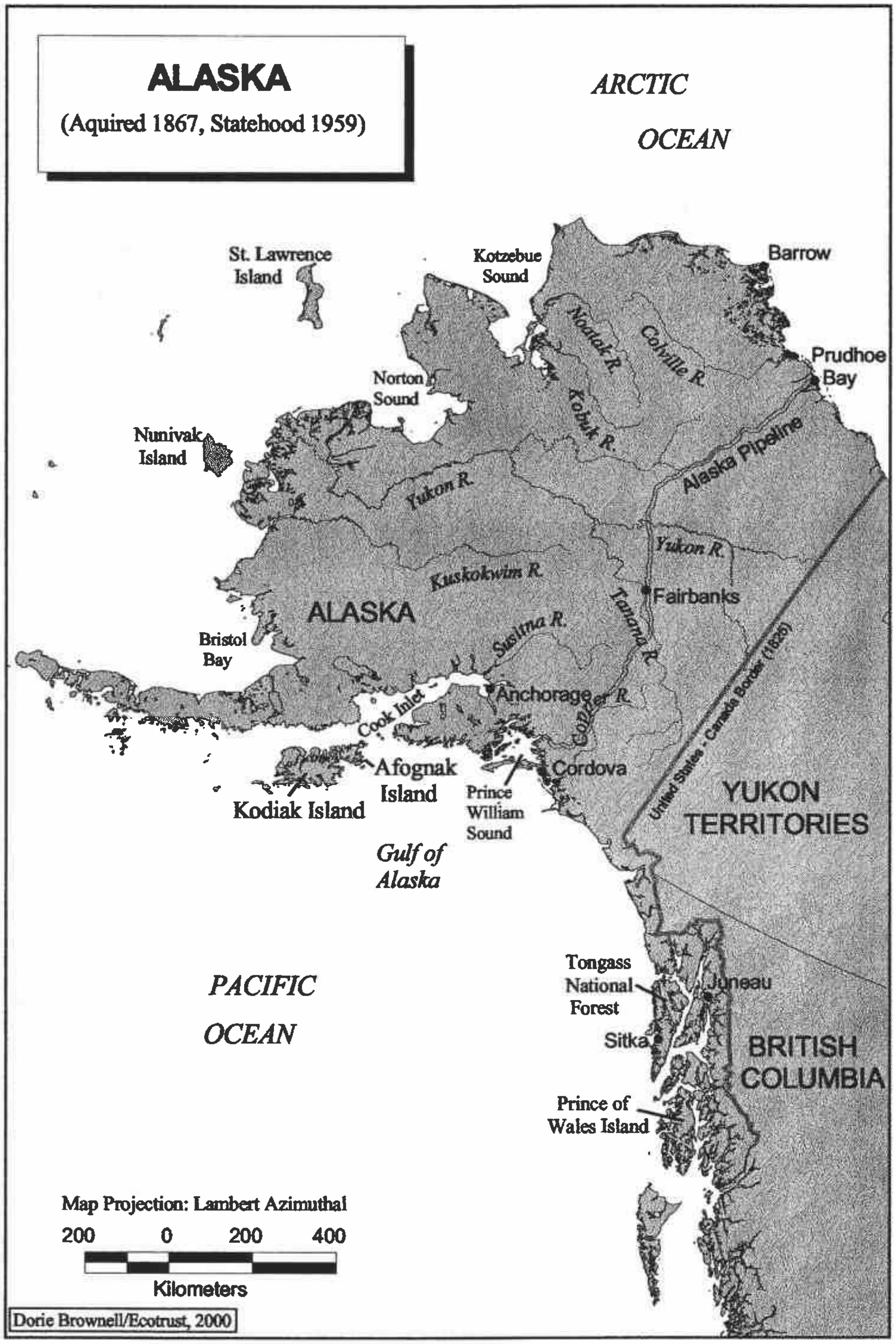

Figure 3.16. The territory and state of Alaska. Source: ESRI Digital Chart of the World (1993) and Rand McNally and Company (1985).

Fish, including salmon, were the mainstay of the Russian American colony, provided to the Russians through barter with native peoples or through wage fisheries (Gibson, 1996, 33; Langdon, 1989, 312). The colonists also obtained meat and potatoes through local trade. All other provisions were shipped in from abroad. Because of General Director Baranov's strategy of relying upon Britons and Americans for provisions and his abuse of native Alaskans, he was removed and the Russian-American Company charter renewed under Russian naval authority. Despite Russian attempts to be self-sustaining through colonies in California and Hawaii, Baranov's provisioning strategies were formalized in an 1839 agreement with the Hudson's Bay Company to provide provisions in exchange for access to furs from mainland southeast Alaska (Gibson, 1992, 264).

Tsar Alexander II approved the sale of Alaska to the United States in 1867, because of the remoteness, vulnerability and declining profitability of the region. The fur trade had declined for several decades, because of overharvest, political turmoil in the Chinese market, and changing US fashions. Russian Alaska was poorly defended, and escaped British attack during the Crimean War (1853-56) only because of a neutrality agreement negotiated between the Hudson's Bay Company and the Russian American Company. The California population boom during the gold rush alarmed Russian officials, who would have been overwhelmed by a similar deluge of independent miners in Alaska, given their tenuous foot-hold on Russian Alaska's west coast. Lastly, Russian acquisition of Priamurye and Primorye from China (1860) provided promise of new wealth closer to home (Haycox and Mangusso, 1996, xx).

Once the United States took possession of Alaska, the US military became the primary government presence in the new Customs District. The Department of Treasury was the overseer of Alaska's fisheries, but had no regulatory authority. United States mining law was the only legislation immediately extended to the new territory, and mining claims were the only legal means to obtain title to land. Alaskan settlers operated a handful of salmon salteries between 1867-78 (Langdon, 1989, 315). Economic activity was negligible until salmon canneries were first built in southeast Alaska in the late 1870s (Haycox and Mangusso, 1996, xxi).

The Commission of Fish and Fisheries was established in the Treasury Department in 1872 to oversee the Alaska fisheries, develop the Northwest fisheries and to aid the failing Atlantic salmon industry. The Commission was underfunded, and dependent upon the goodwill of the fishing industry to cover travel costs to visit its remote grounds (Cooley, 1963).

3.4.2 1870-1896

Settlers struck gold in Juneau in 1880, drawing additional outsiders to the state. Conflicts between natives and newcomers increased, and it became apparent that the territory needed both a civil government and a judicial system. The US Congress granted the Alaska colony limited self-rule in 1884, including a governor, an education agent, and various judicial officials. Oregon's laws were to apply to Alaska, unless they conflicted with federal legislation (Haycox and Mangusso, 1996, xxi-xxii). Congress also appropriated funds for a two-person fish inspection staff for Alaska, to be housed in the US Fish Commission (Cooley, 1963).

The salmon fishery expanded rapidly in the 1870s (Figure 3.17). Bristol Bay sockeye stocks were the initial focus, because strong markets for canned sockeye had already been developed in Great Britain by Canadian canners. Sockeye were abundant and the prolonged runs occurred during mild summer weather. Within twenty years, some local sockeye stocks appeared to be in decline. (These declines are not evident in Figure 3.17, likely due to expansion into new fishing grounds). The US Congress responded to the declines with its first fisheries management measure – the Alaska Salmon Fisheries Act (1889). The Act banned the use of in-river weirs, traps or dams for salmon harvest and directed the Commission to further investigate the fisheries. The Treasury Department's Fish Commission was granted enforcement authority for the first time, but the two-person enforcement staff was not capable of patrolling the Alaska fisheries (Figure 3.17; Cooley, 1963; Pennoyer, 1978, 20).

Although the predominant philosophy of fisheries management in the era was one of laissez-faire, emphasizing the common property and equal access nature of the fisheries, the Alaska situation was different. The remote fishery was dominated by

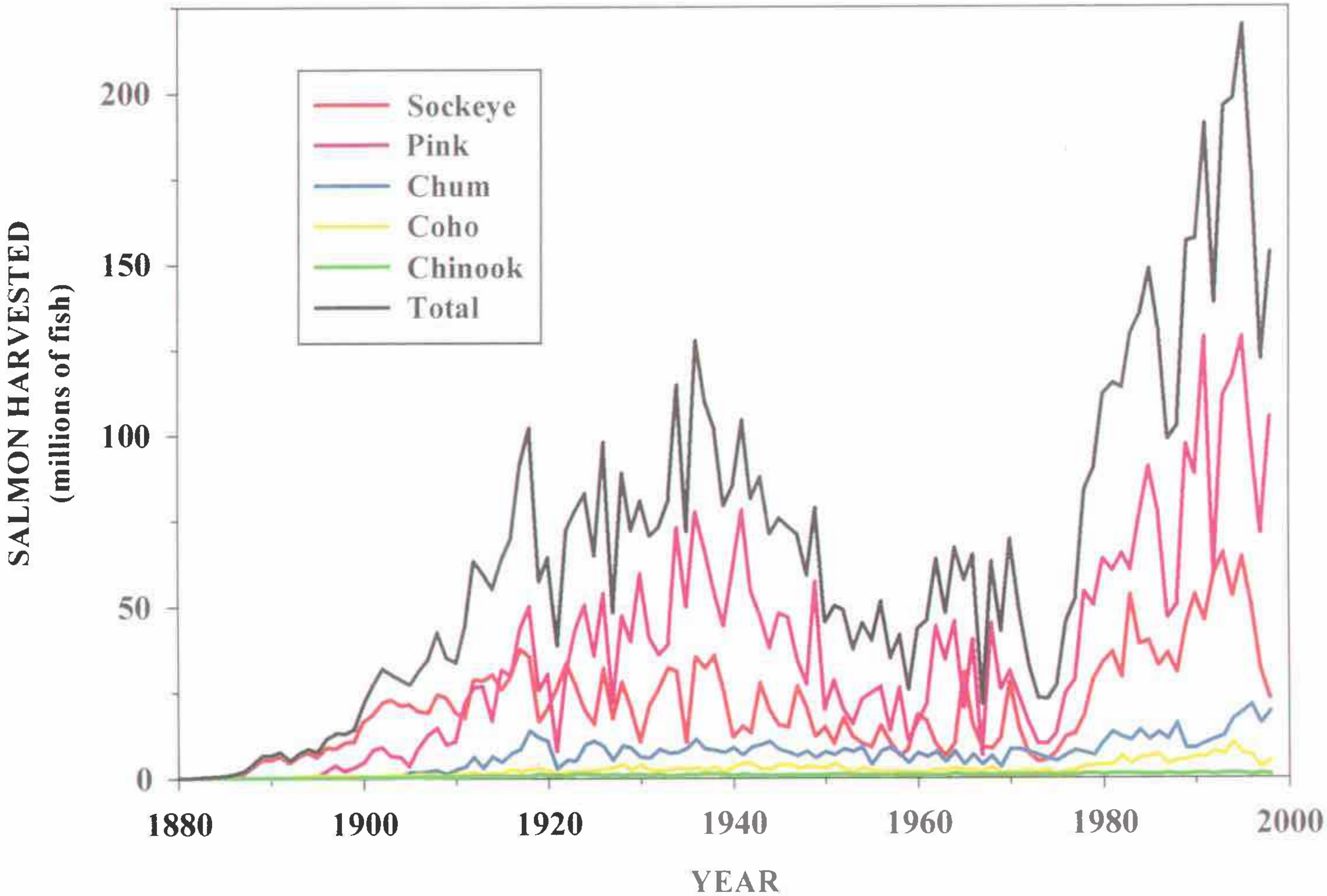

Figure 3.17. Alaska salmon harvests, 1878-1998, in millions of fish. Harvests after 1924 are adjusted to include recreational and native catch. Sources: Byerly et al. (1999), Hare et al. (1999).

salmon canners from the American Northwest, who operated geographically distinct fiefdoms in southeast Alaska. Each "fief" included a salmon cannery and some sort of fish trap -- in-river weirs prior to 1889 and fixed estuarine pound-traps (net traps) after weirs were banned (Langdon, 1989, 316).

The San Francisco-based cannery owners had a strong and growing political voice through the California congressional delegation. The canners favored some form of exclusive rights to the fisheries, but did not support the Fish Commissioner's 1892 recommendation to Congress for a system of salmon leases with associated catch quotas (Cooley, 1963, 74). The Commissioner sweetened the proposition by suggesting that government-funded salmon hatcheries in Alaska would obviate the need for all harvest management, and the canners supported an alternate version of the proposition. The Afognak Forest and Fish Culture Reserve was created as an alternative to harvest regulation in 1892.[14] The inherent contradictions in objectives appeared quite early. The Forest Reserve Act (1892), which authorized President Harrison's proclamation, also authorized the sale of approximately 160 acres of the reserve to be sold to canneries and the construction of two US Commission of Fish and Fisheries hatcheries (Cone and Ridlington, 1996, 343). The proclamation itself banned commercial and subsistence fishing in the Reserve, in order to protect the egg supply for the hatchery. By 1924, all fishing restrictions had been lifted (Lichatowich, 1999, 137).

The Alaska fishery superceded the Columbia's in value by 1887, due in part to over harvest of the Columbia River "June hog" chinooks (Figure 3.17; Lyons, 1969). Several cannery operators merged to create the amalgamated, San Francisco-based Alaska Packers' Association (1893). Association members controlled approximately 90% of the canneries in Alaska, responsible for about 72% of the salmon pack (Cooley, 1963, 28). Alaska salmon harvests increased each season and by 1896 all five commercial species were being harvested (Figure 3.17).

[14] The reserve concept was advocated by Commission staffer Livingston Stone as a means to preserve naturally reproducing salmon populations. The Afognak Reserve was a political amalgam, combining artificial production and limited access under the rubric of a salmon reserve.

The Treasury Department's Fish Commission recommended more stringent Alaska harvest regulations to Congress in 1894. Enacted in 1896, the amendments to the 1889 Act were heavily influenced by San Francisco canning interests. The principal objective of the amendments was to reduce commercial fishing above tidewater and permit additional escapement or, in other words, to reduce native in-river harvests (see Chapter 6). The Secretary of the Treasury was authorized to close fisheries or limit seasons in some places, but major commercial fishing areas were legislatively excluded from regulation. All harvest below mean low tide remained unregulated, which pushed both independent and cannery fishing effort further offshore (Cooley, 1963).

3.4.3 1897-1914

Outside the fishery, the dominant events of this period were the Klondike gold strike in Canada's Yukon Territory (1897; Figure 3.16) and subsequent strikes in various parts of Alaska. The discovery of gold more than doubled Alaska's population in ten years, and generated a great deal of ancillary economic activity. The gold rush focused federal government and congressional attention upon Alaska, leading to new civil and criminal codes and processes for land acquisition (Haycox and Mangusso, 1996, xxiii).

Just after the turn of the century, the salmon fishery was opened to independent Indian and Euro-American fishers by the advent of purse seine gear, which made fishing possible outside cannery turf at river mouths. Initially, seine fishers still had to rely on cannery steamers to transport them to the new fishing grounds. By 1910, the introduction of gasoline-powered engines freed them from cannery transport, but fishers were still reliant on the canneries for markets and financing (Langdon, 1989, 319).

Alaskan salmon harvests accounted for slightly more than 50% of North Pacific salmon production by 1900, but was displaced by Russia as the top salmon producer by 1914 (Figure 3.1).[15] With the lobbying support of the salmon canners, the United States Fish Commission Alaska staff increased to four people (Cooley, 1963). Reflecting the Fish Commission's philosophy that artificial cultivation was the best management investment, the Treasury Department issued a regulation requiring that every canning company operating in Alaska was to establish a hatchery releasing several times the previous season's harvest. By 1903, only one company had complied because of the expense and poor state of technology, and the regulation was soon rescinded. Several bills to create incentives for private hatchery construction were defeated in Congress. In compliance with President Harrison's 1892 Executive Order, a federal hatchery was built on Afognak Island in 1907 (Cone and Ridlington, 1996).

In 1903, Congress transferred authority for fisheries to the Bureau of Fisheries within the newly created Department of Commerce and Labor. The move consolidated various fisheries functions, which had developed in other parts of the federal administration. Fish culturists and other scientists continued to dominate the Bureau of Fisheries, but the central mission of the organization was marketing. The new Bureau was to promote the US fishing industry domestically and overseas -- their principal clientele was the business community. Regulation was not a key objective. Although Commissioner Jordan recommended limiting the number of Alaskan canneries, as was done in British Columbia, the concept was not politically feasible and the Bureau continued to emphasize hatchery development as an alternative to limiting processing or harvests (Cooley, 1963).

Due primarily to gold mining politics, Alaska was allowed to elect a delegate to Congress for the first time in 1906. In response local pressure, Congress passed a new Organic Act for Alaska in 1912, providing for a territorial legislature and limited self-government. Salmon canners feared additional taxation and tighter regulation, and successfully lobbied to prohibit territorial control over fishing and hunting. Several Alaska governors subsequently lobbied for federal licensing of canneries, in

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[15] Given that pre-WWII Russian harvest figures may include some or all Japanese land-based harvests in Russia, it is possible that Japan was actually the principal salmon producer at the onset of WWI.

order to check the extensive growth of the industry at the expense of Alaska residents. Alaskans also lobbied to ban floating salmon traps (Cooley, 1963).

Floating salmon traps were introduced to the Alaska fishery in 1907. They differed from stationary traps in that they did not require soft bottom and shallow waters in order to pound in pilings. Traps could henceforth be established on salmon migration pathways in the channels of southeast Alaska and Bristol Bay, outside Bureau of Fisheries' jurisdiction (Langdon, 1989, 321). The capital-intensive, labor-saving traps concentrated harvesting power in the hands of cannery operators, and soon accounted for over 40% of the salmon harvested in Alaska. Part of the reason for such concentrated control over salmon harvest in Alaska was the scarcity of local harvesting and processing labor. By this time it was standard practice for most canneries to hire fishing and processing crews on "China contracts" and ship them to Alaska for the duration of the salmon season (Cooley, 1963, 30-32).

The contract system, run by Chinese bosses in San Francisco and Seattle, continued to provide most of the processing labor for Alaska canneries through the early 1900s. Congress made the 1882 Chinese Exclusion Act permanent in 1904, and the cannery labor force slowly became more mixed. Remaining Chinese personnel were increasingly skilled, and developed closer ties to the contracting canneries. Just as the floating traps reduced cannery dependence on contract fishers, processing innovations such as the iron butcher reduced the need for skilled labor during the early 1900s (Friday, 1994).

An array of lobbying organizations were formed just prior to WWI. The Alaska Native Brotherhood formed in 1912, principally to attain citizenship for its members. It also lobbied to ban floating fish traps, as they hurt the livelihoods of native in-river fishers (Langdon, 1989). The Association of Alaska Salmon Canners was also formed in 1912, and joined forces with the Puget Sound Salmon Canners' Association to retain permanent representation in Washington, D.C. Reflecting north-south and cross-species industry integration, the Association of Pacific Fisheries was created shortly thereafter to represent salmon, halibut, cod and other fish processors (Cooley, 1963).

Alaskan residents became increasingly vocal in their pleas for federal intervention in salmon management. Native cannery workers were displaced first by Chinese and then Japanese contract crews, and Alaska-based fishermen were marginalized by the cannery shift away from independent fishermen to fish traps. Harvesters went on strike in support of a ban on floating traps, but as a result simply motivated the canners to invest in more traps (Cooley, 1963).

3.4.4 1915-46

Alaska's economy at the turn of the century was based upon copper and salmon. Although WWI created booming markets for both commodities, the economy was strained because of labor shortages, because of war-time conscription (Haycox and Mangusso, 1996). Access to outside, seasonal labor, allowed the salmon industry to continue to grow. The number of Alaskan canneries almost doubled between 1915-1920, and the first peak in salmon production was attained in 1918 (Figure 3.17; Crutchfield, 1969, 95). Chum and pink salmon became an important component of the pack during the First World War. Together these two species comprised approximately 63% of the 1918 harvest, in numbers of fish (Figure 3.17).

The relationship between cannery operators and the Bureau of Fisheries became ever closer during the war. Lobbyists for the canners convinced the Secretary of Commerce to open a Bureau of Fisheries Alaska Division office in Seattle, housed in the same building as *Pacific Fisherman* magazine, the American Can Company, and twenty of the major canners. The top canners in this era were known collectively as the "Fish Trust" (Cooley, 1963).

Immediately after WWI, there was a glut of Pacific salmon on domestic and international markets. Government purchasing policies and the brief post-war depression that affected all of North America worsened matters for the salmon industry, and a round of cannery consolidation ensued in the early 1920s. Suddenly conservation became good business, as the prospect of limited supplies offered the potential for higher prices (Crutchfield and Pontecorvo, 1969, 95). The canners also sought scapegoats for their shift in fortunes. Fisheries Commissioner Dr. Hugh Smith (1913-1921) was forced out of his position by the fishing industry. Bureau employees agreed that action was needed, but it did not have the jurisdiction to take management measures without Congressional authorization. Congress was reluctant to authorize the Bureau of Fisheries increased regulatory authority over Alaska fisheries. Once again, the Bureau turned to the President and, using the Afognak precedent, a pair of fish reserves were proclaimed by executive order in 1922. The Bureau's intent was to develop a series of Alaskan reserves covering all of the major salmon fisheries, to limit the number of canneries and attached harvest licenses authorized within the reserves, thereby limiting total harvest within each reserve (Cooley, 1963, 104-107).

The Presidential mandate caused a crisis in Alaska salmon politics. The reserve concept was extremely controversial, because it apportioned harvest rights to outside salmon canneries rather than to individual Alaska-based fishers. The reserves were abolished with the passage of the White Act (1924), culminating congressional debate over a series of forty-two Alaska fisheries bills since 1906. The compromise legislation expressly prohibited exclusive or several right of fishery, and thus struck down the reserves (Cooley, 1963, 124).

The White Act was the first comprehensive fisheries legislation passed by the United States Congress. It enlarged the Bureau's geographic authority within Alaska from a 500-yard radius around river mouths to the limits of the territorial sea (3 nm). Certain areas were established where season openings, gear and harvest volumes could be regulated. The Act included a mandate for a 50% escapement rate, ongoing monitoring and in-season harvest regulation. The Bureau grew rapidly to 146 staff members in 1928, with a fleet of ten vessels. Bureau employees were at last deputized to arrest violators, seize gear, invoke fines and demand prison terms (Cooley, 1963).

Increased enforcement authority under the White Act put regulation in the Alaska fisheries on a par with state enforcement capabilities in the contiguous States and caused a rift between the Bureau of Fisheries and its industry clients. For the next several years, the Bureau was impassive as prices and harvests were steady and the industry relatively satisfied (Figure 3.17; Cooley, 1963, 125-7; Crutchfield, 1969, 96).

The number of canneries operating in Alaska peaked in the late 1920s (Cooley, 1963, 42).

By the early 1930s, the number of canneries and working traps in Alaska had diminished by half, because of cannery consolidations and bankruptcies at the onset of the Great Depression. The remaining canners still increased the pack and their profit margins, because of efficiency gains in processing made in the 1920s. Sockeye salmon prices remained high through the 1930s. Prices for pink and chum salmon increased somewhat more erratically, driven by war-time demand more than consumer interest (Cooley, 1963, 56). Total Alaska harvests varied from year to year, but continued a steady increase until attaining a second peak in production in 1936 (Figure 3.17).

Fishery workers were unionized during the early years of the Great Depression. By the late 1930s, Alaskans became alienated from the unions. The Alaskan and union agenda had overlapped in seeking the abolition of the "China contract" labor system. However, the unions were based in Seattle and San Francisco, where seasonal laborers resided, thus union policies were more often unfavorable to Alaskan interests. The combination of labor, capital, and government antipathy or, at best, neglect fueled Alaskans' drive for statehood. Alaskans elected Territorial Governor Ernest Gruening in 1939, a forceful politician who did all in his power to prepare the Territory for statehood. One of his first agenda items was to raise sufficient funds to support a state government, by taxing major industries such as fisheries and mining for the first time (Cooley, 1963).

In addition to company consolidation, canners reacted to unionization and soft markets by strengthening their lobbying associations to increase industry political clout. The Canned Salmon Industry, Inc., represented more than 90% of Alaskan production capacity in 1940. The canners also strengthened their ties with the mainstream National Fisheries Association, and an Alaska cannery owner chaired the Secretary of Commerce's Federal Fishery Advisory Committee for several years (Cooley, 1963, 135-6).

President Roosevelt's politics (1932-1944) led to changes in Bureau of Fisheries policy and practice. Roosevelt's appointee to lead the Fish Commission was a land developer, who favored local control and economic development. Restrictions on mobile gear were reduced and a preference was expressed for Alaskan jobs. The two federal salmon hatcheries were labeled an industry subsidy and closed down, justified by Canadian research regarding hatchery ineffectiveness. The industry did not support the Commissioner's new agenda, and bolstered by Depression-era cost-cutting zeal, pressured Congress to reduce funding for enforcement and research as well. Seasonal regulations for the Alaska fisheries became the subject of intense lobbying – although the Bureau had succeeded in loosening mobile gear regulations, it did not succeed in tightening any other regulations in order to control total harvest levels. There was a growing battle brewing between mobile and fixed gear users, with continuing efforts on the part of Alaskans to ban traps (Cooley, 1963, 137-140).

Alaskan harvests began a prolonged decline for the first time in 1937 (Figure 3.17).[16] Canners and the Bureau of Fisheries placed the blame on Japanese harvesters, who operated experimental salmon mothership fisheries in Bristol Bay between 1935 and 1938. Resident Alaskans blamed the Bureau of Fisheries and ineffective regulation. The declines generated a great deal of interest in Congress, and many members visited Alaska for the first time. A House-sponsored investigative report (1939) was very sympathetic to the Alaskans, but did not lead to legislative change (Cooley, 1963). Because of dissatisfaction with Alaskan fisheries administration among Alaskans, cannery owners and in Congress, Roosevelt's Commissioner resigned in 1939 and the trusteeship for Alaska fisheries (and all US fisheries) moved to the newly created Fish and Wildlife Service (FWS) within the Department of Interior. The new administrators hoped to involve Alaskans and Seattle canners in management, but their efforts were swept away by rising prices and soaring salmon markets during World War II (Cooley, 1963, 156).

[16] In contrast to the brief post-WWI decline and quick recovery, induced largely by the post-war depression and collapse in international salmon markets.

As soon as WWII began, salmon prices soared and harvest effort intensified. Prices for canned salmon increased 25% between 1940 and 1942, accounting for inflation. Restricted areas were opened, seasons extended, and weekly closures to promote escapement were eliminated. The federal government mandated cannery consolidation, increasing the efficiency of processing operations. The number of canneries naturally declined because of war-time labor shortages. The number of fishing boats was steady through WWII, because of shortages of manpower (Cooley, 1963, 157).

High prices to mobile gear fishers during WWII and through 1948 induced the entry of many new seiners and gillnetters, just as canneries were consolidating and closing down. Seasonal part-time fishers were a new element among the mobile gear group, including an increasing number of out-of-state mobile gear fishers. Canneries continued to be profitable as long as demand and prices were strong, despite declining salmon harvests (Figure 3.17; Cooley, 1963).

3.4.5 1947-1975

After the war, there was a rapid resurgence in the number of mobile gear harvesters. Motorized boats were allowed into the lucrative Bristol Bay sockeye gillnet fishery for the first time in 1951, and the first serious influx of Alaska residents into the fishery began. The seine fleet also increased, although much of its growth occurred during the 1930s after cannery consolidations and trap closures made additional salmon runs available. While the average catch per boat declined, the fisheries remained profitable through the early 1950s because of high salmon prices, drawing yet more entrants to the fishery (Cooley, 1963, 49-58).

Alaska Territory won a major battle with the salmon canners in 1949, when Governor Gruening at last succeeded in passing tax reform. Fish harvests (and mining proceeds) were now taxable, and Alaska was on its way to generating sufficient funds to support a state government. The Territory immediately established its own Department of Fisheries using the new tax proceeds. Although the Department had no administrative authority, it worked side by side with the FWS' Bureau of Commercial

Fisheries to conduct research and monitor the fisheries. Federal research funding increased nine-fold between 1948-58, because of the panic about crashing pink and sockeye salmon stocks (Figure 3.17; Crutchfield, 1969, 102).

Harvests in 1953 (37.5 million salmon) were so much lower than the preceding seasons that President Eisenhower proclaimed disaster areas in several regions of the Territory (Figure 3.17). Mobile gear harvesters were increasingly constrained by time, area, and gear restrictions. Violations were numerous as there were too many fishers chasing too few fish, and enforcement efforts were spread thin. In 1956, area licensing regulations were put into effect to prevent the large mobile fleets from shifting from run to run during the salmon season. In the absence of limits on new entrants to the fishery, by 1959 the number of harvesters per management area was almost what it had been when the fleets were allowed to rove (Pennoyer, 1978, 22). Given that British Columbia was producing a steady, large volume of salmon at the time, almost all parties were convinced that the Alaska fisheries were in crisis (Figure 3.1; Cooley, 1963).

British Columbia's fishery rationalization and limited entry debate spilled over to the Alaska fisheries during the 1950s, but Alaskans felt very strongly about preserving open access. Alaska achieved statehood in 1959, and responsibility for fisheries management was transferred to the new Alaska Department of Fish and Game (ADFG). Demonstrating the centrality of the fisheries, Alaska's Constitution mandates sustained yield fisheries management. As originally written, it also prohibited any form of entry limitation to the fisheries.

One of the first acts of the Fish and Game Board was to ban floating fish traps. The prohibition prompted another surge in the size of the mobile gear fleet (Pennoyer, 1978, 23). Trollers fished Alaska waters as well as gillnetters and seiners, but the troll fleet was less subject to the vicissitudes of cannery operations. Troll-caught coho and chinook sold fresh or frozen filled a high-value niche market, in comparison to the high volume pink and chum fisheries or the high-value/high-volume sockeye, all of which were processed by canning (Cooley, 1963, 47).

Immediately following statehood and state assumption of salmon management, harvests improved modestly for several years in the 1960s (Figure 3.17). Many assumed that state management was beginning to make a difference, and that the major reason for the depressed runs was the resumption of Japanese high seas salmon fisheries, limited by the International North Pacific Fisheries Convention to the area west of 175° W longitude (Figure 8.2). Japanese harvests may well have had a significant effect. Beamish and Bouillon (1993, 1006) estimate that Russian, Alaskan and Canadian production losses from Japanese high seas harvests peaked in the 1950s at about 45,000 MT of sockeye, pink and chum salmon, then declined until the early 1970s.

However, the fisheries crashed again in 1967 and from 1973-1975 (Figure 3.17). Sockeye and pink salmon stocks, the most abundant species and the cornerstone of the canned salmon business, were the most depressed (Byerly et al., 1999, 4). The pink salmon fishery in Prince William Sound was completely shut down.

The dire state of the salmon fisheries sparked renewed debates about limiting entry. What the Alaskans really wanted was to exclude outside harvesters from fishing within state waters. The legislature authorized the Board of Fish and Game to close certain fishing areas to non-residents in 1962, but the legislation was struck down as a violation of the Commerce clause of the US Constitution. After the disastrous 1967 season, the Alaska legislature authorized a license limitation system. Although the new law passed muster before the US Supreme Court, it was invalidated by the Alaska Courts as it violated the state constitution's mandate for open access. Alaska's present limited entry system was created in 1973, after the passage of a constitutional amendment permitting entry restrictions if necessary to conserve resources or prevent economic distress (Petterson, 1983, 314-315). (For details regarding the allocation of harvest rights see Chapter 6).

The string of poor harvests beginning in 1973 generated a grassroots movement among fishermen and their elected representatives to reinitiate an Alaska hatchery system. Alaska's approach was distinctly different from that in the American

Northwest. On the basis of US and Japanese experience, Alaskans created a hybrid public-private system. They did not want private corporate hatchery operations in Alaska, similar to (short-lived) ventures in Oregon and Washington states. In 1974, the legislature authorized non-profit corporations to run salmon ranching operations, and created a state loan program to build the hatcheries and establish broodstocks. It also created a system of regional aquaculture associations, composed of fishermen and local residents in a given area. The latter differ from the non-profit corporations in that they are representative membership organizations, which can vote to tax their harvester-members on the basis of ex-vessel landings to support salmon enhancement activities. A new Alaska Department of Fish and Game Fisheries Restoration and Enhancement Division (FRED) was created to oversee the private hatcheries and to begin a complementary state program. The hatchery system is regulated by ADFG, with policies to control broodstock development, disease control, interaction with wild stocks, etc. (McGee, 1999). The ambitious program was made possible by Prudhoe Bay oil revenues, which began to fill state coffers by the early 1970s (Haycox and Mangusso, 1996, xxviii).

3.4.6 1976-2000

The passage of the Magnuson Fishery Conservation and Management Act (MFCMA or Magnuson Act, 1976) marked the entry of the federal government into salmon harvest management in the United States. Alaska is, once again, an exception. In contrast to the contiguous states, which share commercial salmon stocks with each other as well as several sovereign tribes and conduct a troll fishery outside the three-mile state management zone, Alaska's commercial fisheries all occur within state waters. The North Pacific Fishery Management Council, created by the Magnuson Act to manage fisheries in the Exclusive Economic Zone (EEZ) off Alaska, does not have a salmon plan (Figure 3.2). Authority for salmon management in Alaskan waters is vested with the Fisheries Board and the Alaska Department of Fish and Game.

Alaska harvest levels began to recover circa 1976, when climate conditions became more favorable for Alaskan salmon reproduction and less so for the American

Northwest salmon stocks (Hare et al., 1999). The 1983 sockeye harvest exceeded the 1918 peak canned salmon pack, and exceeded all historical harvests by 1993. Pink harvests exceeded historical records in 1985, and broke past records yet again in 1999 (Figure 3.17; Byerly, 1999, 4-5; Ess, 1999). Improved Alaskan harvests in tandem with declining Pacific Northwest harvests drew more non-resident harvesters to Alaskan waters in the late 1970s. Harvest permits in Alaska are freely transferable, and many were bought by Northwesterners feeling pinched by falling harvests, Boldt Decision quota reallocations, and new local limited entry programs (Natural Resources Consultants, 1986).

At its peak in 1987, the Alaska hatchery system consisted of thirty-nine public and private operations, nineteen owned and operated by the state. When oil revenues began to dwindle, the legislature created a program to contract hatchery operations to the private and non-profit sector. The profitable hatcheries (eleven) are now operated by either regional aquaculture associations or non-profits. Three hatcheries, rearing coho, chinook, steelhead and other sport fishes for the sport fisheries and financed by federal sport-fishing taxes, are still operated by Alaska Department of Fish and Game. The remaining state-run hatcheries were closed down, and the Restoration and Enhancement Division was eliminated. Hatchery oversight is now exercised by a few specialists within ADFG's Commercial Fisheries Division.

Presently, Alaska's hatcheries are operated primarily by the private sector. Three hatcheries are operated by the Fish & Wildlife Service or the Bureau of Indian Affairs. Fourteen hatcheries are owned and operated by the regional associations and non-profits, rearing primarily pink (69%), chum (24%) and sockeye (5%) salmon. Two regions, Prince William Sound and Southeast, account for 81% of hatchery returns. The hatcheries are estimated to contribute 25% of the salmon to the all-Alaska common property harvest, with great variation by species and region. For example, more than 75% of the commercial common property harvest in Prince William Sound was composed of hatchery-origin fish (McGee, 1999; McNair, 1999, 1-2).

3.5 American Northwest

Fisheries management in the contiguous United States fell within state or territorial jurisdiction to the outward extent of the 3-mile territorial sea until 1976. The fisheries in each of the contiguous states and territories were subject to the governing structures and politics of the individual jurisdiction. California attained statehood very quickly after becoming a United States territory in 1850, and was followed by Oregon in 1859. Presidentially-appointed governors and officials managed Washington and Idaho Territories until they achieved statehood in 1889 and 1890, respectively.[17]

3.5.1 Pre-1870

The adoption of horses on the Columbia Plateau and in the Great Basin in the late 1600s facilitated greater trade and socio-economic integration among inland Indian tribes (Hunn, 1990, 23-27). Ethnographic evidence points to extensive trade among coastal tribes all along the west coast of North America and between coastal and inland tribes along east-west rivers such as the Columbia, prior to European influence (Gibson, 1992, 7-11).

People aggregated, seasonally or permanently, wherever salmon resources were abundant and reliable enough to at least provide winter food supplies. The Northwest Coast cultures from the mouth of the Columbia northward to the Canadian border had highly developed salmon rituals, similar to their northern counterparts in present-day British Columbia and southeast Alaska. The coastal peoples were also dependent to varying degrees on marine mammals and other marine resources. East of the Cascades, the Plateau tribes subsisted on salmon, plant foods and large game (Boyd, 1996). Further east, the Great Basin tribes were increasingly dependent on seeds and

[17] The thirty-year lag between Oregon and Washington statehood was driven both by settlement rates and by national politics. Washington and Idaho were strongly Republican states, but Congress was dominated by the Democratic Party. The Democratic Congress did not approve statehood for the two Territories until it became a lame duck, to be succeeded by a Republican majority in 1888 (Schwantes, 1989).

small game, as well as riverine fishes including salmon. Inland salmon harvests were particularly notable among the tribes in the Snake River system, such as the Lemhi Shoshone-Bannock (see Walker, 1993).

The best salmon abundance and harvest estimates for the contiguous United States have been developed for the Columbia River basin, because of the contentious allocation issues and treaty rights litigation in the region. The Northwest Power Planning Council has adopted a figure of 11 to 16 million salmon, including steelhead, as a baseline for historical salmon abundance (Northwest Power Planning Council, 1986, 71). Anthropological and ethnographic assessments place average per capita consumption at approximately 288 kg/year (Schalk, 1986, 19; Walker, 1993, 246). This per capita assessment likely understates pre-European consumption, as it does not account for salmon consumed as dog food and fuel, or salmon preserved for trade (Schalk, 1986, 19-20). Early analyses hypothesized that native salmon consumption dropped dramatically because of epidemic-induced population declines by the early 1800s. It is now more broadly accepted that upriver tribes that suffered less because of distance from disease sources would have stepped in and taken over any vacant fishing areas, or harvested relatively more salmon upstream at their traditional fishing sites (Schalk, 1986, 22-23).

The western United States were colonized by several countries: Russia, Great Britain, Spain, and the fledgling United States. Once colonization began, settlement and development of western resources proceeded competitively between the British-chartered Hudson's Bay and Northwest companies, the Russian chartered Russian-American Company, Yankee traders from New England, and the Spanish in California.

Despite the voyage of Robert Gray in 1792 and the passage of Lewis and Clark along the Columbia River in 1805, the American presence was largely in the form of visits by Yankee fur traders rather than permanent settlements. In 1818, Great Britain and the United States signed an agreement providing for joint occupation of the Oregon Country, encompassing present-day British Columbia, Washington, Oregon, Idaho, as well as parts of Montana and Wyoming. American forts Clatsop and Astoria were both short-lived, and did not attract permanent settlers to the region. In fact, Astoria was taken over by the Hudson's Bay Company, and renamed Fort George, served as the HBC's base of operations in its "Columbia Department" for many years.

Great Britain and the United States were increasingly dissatisfied with the joint occupation of the Columbia Department/Oregon Country. "Oregon Fever" began in the 1840s, with a large influx of agricultural settlers from the MidWest. The pace of settlement increased when gold was struck on the Illinois River (Oregon) in 1850. Great Britain considered US settlements to be an infringement upon their lands and the commerce of the Hudson's Bay Company. The two countries amicably resolved that Great Britain should retain all of the territory north of the 49th parallel, and the United States the territory to the south.[18] The transaction was formalized by the Anglo-American Treaty of 1846. Present-day California was acquired from Mexico in 1848. The two transactions created the present-day international boundaries of the contiguous United States (Figure 3.18). The Oregon Territory was congressionally created in 1848, and the US Congress split off Washington Territory in 1853.

The first commercial fisheries in the region were conducted in the Columbia River basin. They were small in scale, relying on Indian labor to produce brined salmon for Company consumption. Great Britain's Hudson's Bay Company sought to export Columbia River salmon to the Hawaiian Islands as part of the fur trade route in 1823. Because of poor preservation and the vast distance, there was a great deal of spoilage. Hawaii did emerge as a stable market, however (Taylor, 1996).

[18] The maritime boundary in the San Juan Archipelago remained in dispute until 1872 (Harper's Ferry Center, no date).

Figure 3.18. The American Northwest. Note that the dams depicted on this map were not built until the 20th century. Sources: ESRI Digital Chart of the World (1993) and Rand McNally and Company (1985).

The Euro-American population of Oregon country was largely composed of transient trappers, with a few small agricultural settlements associated with trading posts. Local salmon markets were inconsequential. The first Yankee salmon export venture occurred in 1829, when the *Owhyee* put up salmon for two years in the Pacific Northwest, then sailed for Boston. This venture was also unprofitable because ofspoilage. Despite difficulties in obtaining regular supplies of barrels and salt, and the challenges of transportation, there were several salmon salteries operating by the 1860s (Smith, 1979, 16-17). Spoilage was the major obstacle to the development of distant markets (Taylor, 1996, 94-96).

By the 1850s, the Indian population had diminished to the point that accustomed fishing sites could no longer be protected, and the Indians began to lose monopoly control over fishing. Malaria and other diseases took a toll on native peoples up and down the coast, further disrupting traditional culture and subsistence as the number of able-bodied people per family or clan socioeconomic unit diminished. Settlers as well as merchants began to compete with the Indian population for salmon, as local demand for fish began to grow (Taylor, 1996, 95).

California salmon entrepreneurs organized to brine salmon on the Sacramento River in 1848, but had to set aside their plans after the gold strike, because of the lack of labor. Prior to the gold rush, there had been no market for salmon in California, because the sparsely settled Californians had abundant supplies of beef. Yankee traders and immigrants brought the salmon business to California from New England, where Atlantic salmon was in decline because of a combination of waterway obstructions, pollution and overharvest. Gillnetting began in the Sacramento River in the 1850s, but the fleet did not realize its full potential because of labor volatility and salt shortages. Markets were both local and as distant as Australia (McEvoy, 1986).

The industry changed dramatically after the first cannery in the North Pacific was established on the Sacramento River by New Englanders Hapgood and Hume in 1864. The venture was marginally successful – Californians were not interested in canned salmon, as they could buy it fresh. The major markets were in Australia, New Zealand, Great Britain and Latin America. A combination of cyclical salmon run declines, mining-related pollution on the Sacramento, and summer heat which led to rapid spoilage led the partners to move their enterprise north to the Columbia River basin in 1866 (Friday, 1994; McEvoy, 1986).

Salmon canning quickly became a competitive business on the Columbia River, with seven canneries in operation by 1873, and fourteen just two years later (Figure 3.19). There was initially enough labor and demand that the early operations were very profitable (Smith, 1979, 17-18).

Early fisheries regulations promulgated by the states and territories were primarily distributive in nature. Beach seining was prohibited on a particular stretch of the Washington coast in 1859, and limitations were placed on the span of fish traps on various rivers in the 1860s. Although the latter measures were made in the name of conservation, it is likely that they were aimed at reducing or eliminating in-river Indian fisheries (Cone and Ridlington, 1996, 81; Phinney, 1976).

The fisheries agenda at the national level was propelled by the disastrous decline of the Atlantic salmon fishery in New England. The New England states investigated fish culture as a solution as early as the 1850s. The states were uncomfortable with the idea of producing fish, as that was a private sector function. Yet there was no financial incentive for individual entrepreneurs to engage in artificial cultivation, given the state of New England's waterways and the risk of fish produced being intercepted by independent fishers. The first association of fisheries biologists was formed by fish culturists intent upon promoting their craft (American Fish Culturists' Society, 1870). The Society and the New England states turned to Congress to seek financial assistance to attain their goal of restoring Atlantic salmon to eastern rivers. The Administration had also been pondering these issues, and created the US Fish Commission in the Department of Treasury the same year. To secure support for hatchery appropriations, the Commission agreed to fund a hatchery on the Sacramento River and shad propagation in Mississippi as well as hatcheries in New England (Lichatowich, 1999, 119-122).

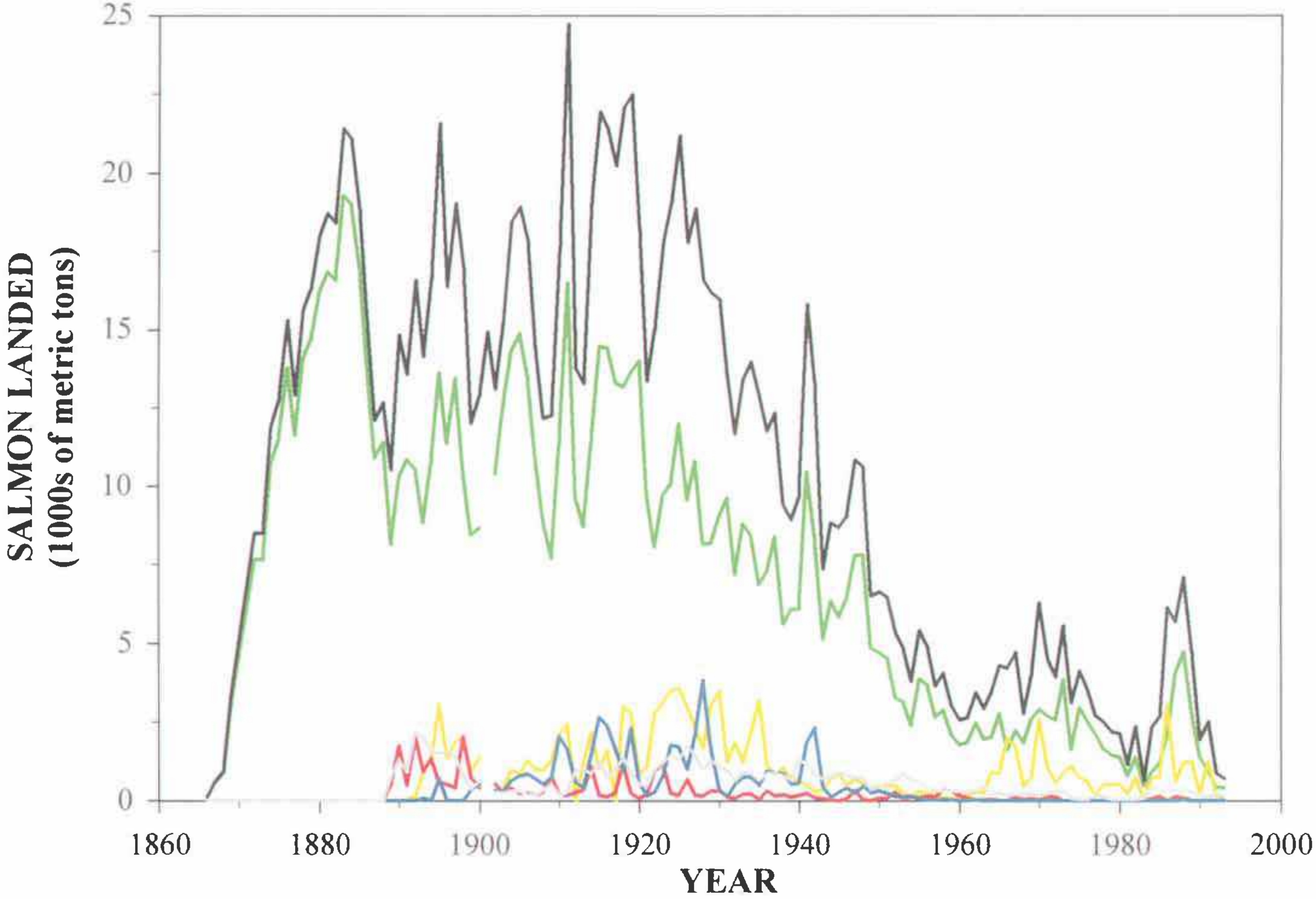

Figure 3.19. Columbia River salmon harvests, 1866-1993, in thousands of metric tons. Source: Joint Columbia River Management Staff (1994).

3.5.2 1870-1896

The first federal fisheries activity in the Pacific Northwest States was Livingstone Stone's expedition to the Sacramento River to find a source for Pacific salmon eggs for transplantation to eastern rivers. He established the McCloud River hatchery in 1872, and over the next eleven years stripped the McCloud system of 30 million salmon eggs, and produced no appreciable returns for the McCloud itself. Eastern shad was traded to the Californians in exchange for the chinook eggs (Lichatowich, 1999, 123-25).

By the late 1870s, Columbia River canners and their California and midwestern financiers began to seek other sources of salmon (Figures 3.19 and 3.20). A cannery began operations on the Rogue River in 1876, and the first cannery opened on Puget Sound the same year. The number of canneries peaked on the Columbia River at thirty-nine in the mid 1880s. Columbia River canners packed more salmon in 1883 than any year thereafter except 1895. Chinook harvests exceeded 14,000 mt/year between 1878-85, comprising the majority of the harvest. Peak sockeye and steelhead harvests in the Columbia system occurred during the 1890s (Figure 3.19).

Harvests after 1924 are adjusted to represent tribal and recreational harvests as well. Oregon chum harvests were omitted by Hare et al. (1999) as insignificant. All of the major Pacific Northwest salmon runs were being fished by the late 1880s, except for those on the remote northwest Washington coast (Lichatowich, 1999, 87-88). One of the major problems during this period of frenzied production was the lack of cannery capacity at the peak of the season, leading to high-grading by fishers and a great deal of wasted fish. In the absence of refrigeration, the fish had a very short shelf-life prior to processing. Harvest data from this period, based principally on salmon pack, may grossly underestimate actual harvests (Figure 3.20; Lichatowich, 1999, 93-94).

Although several state fish and wildlife laws were passed in the 1880s and 1890s, they were difficult to enforce and frequently altered because of battles between gear groups and their representatives. Oregon state created a Fish Commission in

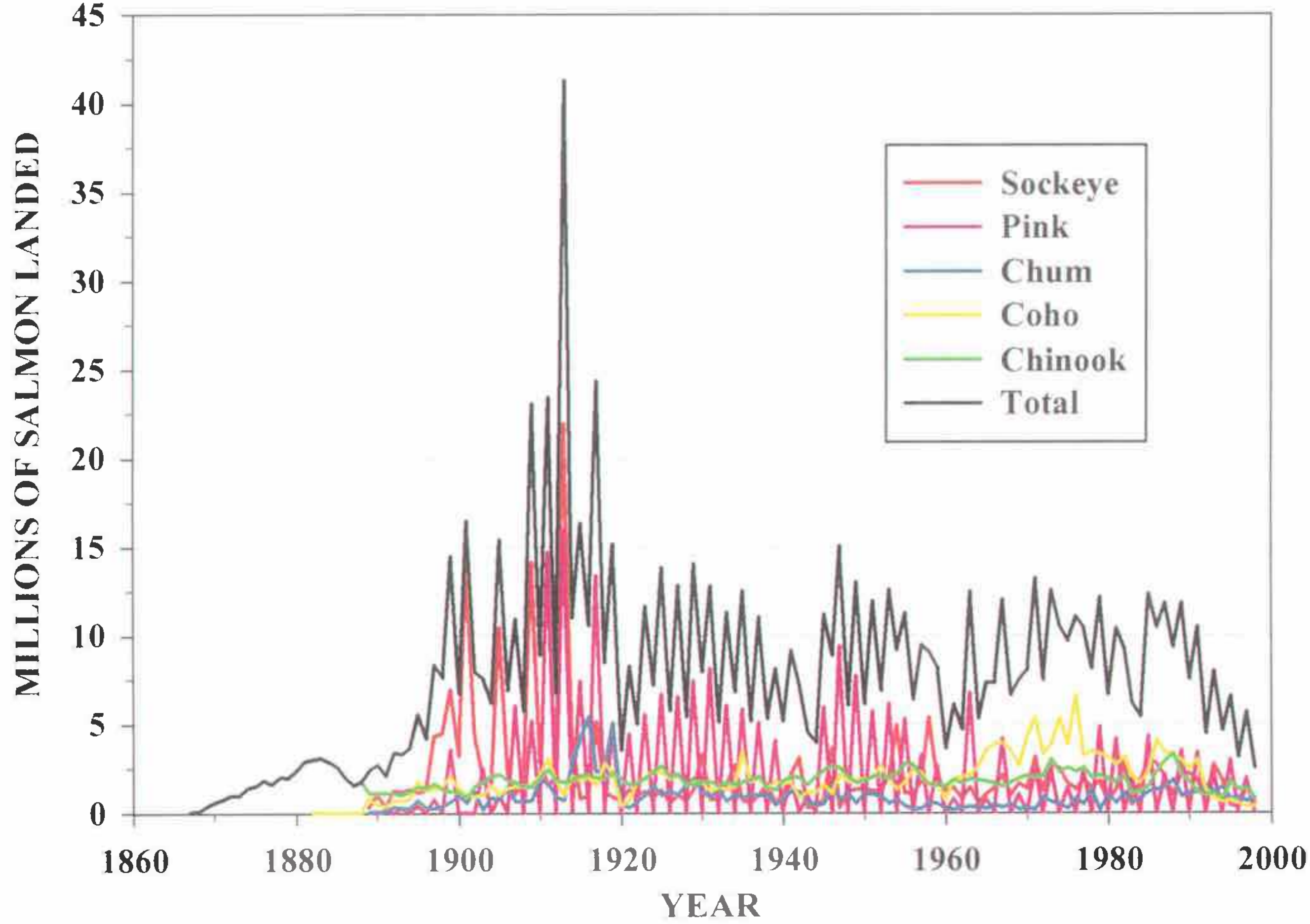

Figure 3.20. American Northwest salmon harvests, 1867-1998, in millions of fish. Includes Washington, Oregon, and California, harvests, omits Idaho. Harvests after 1924 are adjusted to include recreational and native catch. Sources: Hare et al. (1999), Shepard et al. (1985).

1878, and passed its first restrictions on in-river fishing gear and seasons the same year. Oregon attempted to institute fishing licenses, but the endeavor was proclaimed unconstitutional by the Oregon Supreme Court (Taylor, 1996, 179).

The Washington Territorial Legislature imposed gear restrictions as early as the 1860s, although they were virtually unenforceable because of the lack of personnel. The Washington Department of Fisheries and Game was established upon attainment of statehood in 1890, and Idaho created its Office of the Fish and Game Warden in 1893. "Closed season" regulations changed particularly frequently and were ineffectual on the Columbia River, because Washington and Oregon regulations often differed. As in other regions, many of the early norms restricted the span of fish traps, weirs and the use of seines in rivers (Cone and Ridlington, 1996, 81-83). These regulations were offered in the name of conservation in order to promote escapement, but they differentially affected the Indian fisheries, last in line on the salmon's return migration (Smith, 1979, 83).

Columbia River canners tried to limit salmon production in order to boost prices in the mid-1880s. They were unable to come to agreement, because of the vast difference in interests between established canners and newcomers (Smith, 1979, 21). Fishing and harvesting labor was a chronic problem in the early days of the commercial fisheries. The first Chinese processing workers were employed on the Columbia in 1872, and the "China contract" system was in place by the time the first US exclusion act was passed in 1882. The harvesting sector was dominated by various Euro-American ethnic groups, who zealously protected their fisheries from outside ethnic groups. In 1880, most harvesters were also out-of-state, seasonal employees, who fished boats and gear belonging to the canners. Gillnets, fish traps, fish wheels, haul seines and dipnets were the principal gear types, listed in rank order of volume produced on the Columbia River. Purse seines were introduced in Puget Sound by Austrian fishers in the 1890s (Smith, 1979, 37-38).

Gillnetters were by far the most abundant gear group, fishing in tidewater within rivers and estuaries. Columbia River gillnetters formed the Columbia River Fishermen's Protective Union in the late 1880s to demand higher prices from the canneries, to protect prime fishing grounds from other gear groups, and to develop regulations favorable to gillnetters. A lease-to-own system was developed by the canners and gillnetters shortly thereafter, and the gear group conducted a strike for higher prices in 1896. Previously, most vessels were cannery-owned. Unlike Alaska and the Puget Sound, fish traps on the Columbia River were independently owned. Canners attempted to control their fish supplies on the Columbia by operating seines and fishwheels (Smith, 1979, 23-30). Battles erupted between the gear groups in the Columbia River and in other fisheries, as the various gear groups struggled over the best fishing sites and for better prices from the canneries (Smith, 1979, 91).

Scientific and fiscal support of hatchery programs became the major role of the federal fishery agencies in the Pacific Northwest for several decades. Columbia River canners were aware of the decline of premium chinook "June hogs" by the 1870s, and petitioned US Fish Commissioner Spencer Baird for assistance in preventing the Columbia stocks from declining. Baird responded that habitat alteration, dams and over harvest would eventually destroy Pacific salmon stocks just as they had Atlantic salmon. The Commissioner's view was that harvest regulation though desireable, was unenforceable, and that artificial propagation was the only solution to the dilemma. Livingstone Stone was sent to assist the coalition of canners, incorporated as the Oregon and Washington Fish Propagating Company, to found the first Columbia River basin salmon hatchery on the Clackamas River (Lichatowich et al., 1999, 125). The hatchery was difficult to run because of pollution from nearby mills, use of the river for log-rafting, and the construction of a dam below the hatchery. The canners soon leased the hatchery to Oregon, which proceeded to transfer it to federal ownership just a year later in 1888 (Taylor, 1996).

US Commissioner Baird argued for state harvest regulations, and Congress authorized the Commission to withhold hatchery funding if the states did not regulate their fisheries. The Fish Commission role was limited to artificial propagation, because of the lack of federal jurisdiction with the 3-mile territorial sea. Other federal agencies had a much greater effect on salmon abundance in the Pacific Northwest states, by creating the framework for the use of minerals, water, rangelands and forests (see Chapter 5).

3.5.3 1897-1914

The salmon pack in Puget Sound overshadowed all other production areas in the American Northwest by the turn of the century [clear dominance of sockeye and pink over coho and chinook by 1900, (Figure 3.20; Lichatowich, 1999, 90). Columbia River harvests declined because of declining spring and summer chinook runs. The Columbia River Packer's Association was created in 1899 to combat increasing harvester price demands and low market prices for Columbia River fish. Production was held in check to bolster market prices (Smith, 1979, 54). Recorded harvests in the Columbia Basin hit an all-time peak in 1911, but the number of cases packed was lower than in 1895 (Figure 3.19; Smith, 1979, 110-11). This is likely because of the inclusion of more chum and coho in the pack, smaller fish with a lower flesh to offal ratio. Seasons were gradually extended at the turn of the century, and a full-fledged fall chinook and coho fishery was in place by 1909.

There was a distinct move offshore (beyond the 3-mile territorial sea) at the beginning of the 20th century. Gasoline engines were introduced at the turn of the century, making salmon trolling feasible. The California-Oregon-Washington ocean troll fisheries for coho and chinook developed in the early 1900s, in part as a means for dodging increasing and contrary regulations within Washington and Oregon waters. In the Columbia River basin, for instance, trollers could legally supply processors with salmon while the in-river fishing season was closed in the late summer. Premium chinook were brined and shipped to European markets for smoking, after the advent of cold storage facilities (Smith, 1979, 84). A Lower Columbia River and offshore purse seine fishery emerged shortly thereafter, soon spreading to the north and south along the Washington and Oregon coasts. Purse seining was outlawed along the Oregon coast in 1907, but permitted on the Columbia River as they were still legal in Washington State (Cone and Ridlington, 1996, 82).

The shared Columbia River fishery (Washington, Oregon, and Idaho) was particularly challenging to manage. The institutional arrangements for fisheries management were different in each state, but in Washington, Oregon, and Idaho fisheries regulations were enacted by state legislatures. Early fisheries management was highly politicized. Idaho State passed its first commercial harvest regulations in 1907, restricting seining to designated reaches of the Snake and Clearwater rivers (Ortmann, 1976, T-39). In Oregon State gear group politics were extremely fierce. Opposing gear groups mounted initiative campaigns in 1908, in order to ban the other's gear (gillnets and troll gear). Voters passed both initiatives, resulting in an unenforceable near-closure of the fishery. The laws were repealed by the Oregon legislature shortly thereafter (Smith, 1979). The structure of fisheries management in Oregon was altered at least seven times between 1878 and 1921 (Ortmann, 1976, T 31-32).

In 1908, President Theodore Roosevelt recommended to Congress that the federal government take control of fisheries on interstate rivers. Fear of federal intervention spurred the states to cooperate – Washington and Oregon harvest seasons were temporally consistent for the first time beginning in 1909. Legislators in Washington and Oregon appointed joint committees to develop regulations for the Columbia River fishery (Ortmann, 1976).

Although the federal government did not intervene directly in the Columbia River fishery, it continued to support hatchery activities in the region. The states were most involved in hatchery operations at this time – Oregon built Central Hatchery in the Columbia basin in 1909, and eleven hatcheries were in operation on Oregon coastal rivers. Although coho was more abundant in the coastal streams, chinook was initially the principal product because of industry and market demand. Coho fry releases exceeded those of chinook by 1914, because of declining availability of chinook eggs. Egg declines were likely caused by overharvest, splash-dam destruction of mainstem salmon redds, and the practice of racking streams to obtain eggs and milt (Lichatowich et al., 1996, 5-7). Washington also pursued an aggressive hatchery policy, supporting hatcheries in lieu of reducing commercial harvests, enforcing water quality laws on the booming logging industry, or enforcing the requirement for fish passage over dams (Lichatowich, 1999, 131-2).

Sport fishermen laid claim to a share of the salmon resources in the early 20th century. The Sportman's League was established in 1913, as a clearinghouse for state sport fishing groups. The League supported separate management of game (sport) fish from commercial fish. They advocated a dispersed pattern of hatchery siting on numerous small streams, to benefit sport fishers as well as commercial fishers (Mighetto and Ebel, 1994).

3.5.4 1915-1946

Pacific Northwest salmon harvests increased during WWI, just as in the other salmon-fishing nations (Figure 3.20). Columbia River harvests were sustained at more than 19,000 MT for the duration of the war. Although chinook was still the dominant species harvested (72%), steelhead, chum and coho were increasingly significant components of the pack (Figure 3.19). Columbia River sockeye harvests had peaked in 1898, and although they rebounded somewhat in the 1920s, have never since recovered (Joint Columbia River Management Staff, 1994, 113-114).

President Roosevelt's threat to take over the interstate Columbia River fishery eventually led to the Columbia River Interstate Compact, approved by Washington and Oregon in 1915 and ratified by the US Congress in 1918. The mainstem commercial fishery was thereafter regulated by mutual consent of both states, although gear regulations continued to differ in the two jurisdictions through the 1930s (Ortmann, 1976). Idaho was not included in the Compact, and regulated its dwindling upstream fisheries independently. Idaho's last commercial harvests occurred in the 1930s (Ortmann, 1976).

Legislative approval ceased to hamper Washington's fishery regulatory capabilities in 1921, when the Washington Department of Fisheries and the Fisheries Board were created. The fishing industry and researchers strongly supported the reorganization, in hopes that regulations would henceforward be based upon knowledge regarding salmon and the fisheries, rather than politics alone. The Board was unable to win financial support from the state legislature for research and monitoring. Board members advocated harvest limitation to increase escapement, rather than the construction of new hatcheries. The Board ceased functioning in 1927, when its members resigned in unison over a gear conflict in Northern Puget Sound (Crutchfield and Pontecorvo, 1969, 132-133, 136).

Despite a market slump immediately after WWI, salmon markets remained strong in the 1920s, and harvests in the contiguous states reflected the strong demand (Figure 3.20). Harvests of coho salmon peaked on the Columbia River in 1925 and chum in 1928 (Figure 3.19). Sockeye and steelhead harvests were larger than average during the 1920s, but not as large as during their peak harvest years in the 1890s (Joint Columbia River Management Staff, 1994, 113-114).

Gear wars were played out using the initiative process, as the numerous fishers contended for market share. The troll fleet remained relatively small until WWI, when war-time demand for flax greatly increased the cost of linen for gillnets. Many gillnetters converted to trolling at that time (Lichatowich, 1999, 110). Purse seines were banned on the Columbia River by both Oregon and Washington in 1917, and Oregon instituted a troller license requirement the same year. Washington began to license trollers in 1921 (Ortmann, 1976, T-7). Trollers were difficult for the states to monitor, and evaded licensing by stating that they were fishing outside state waters (Smith, 1979, 87).

The gear war was in part a class war against corporate fishing operations. In the Columbia River, cannery-owned fish wheels and drag seines were banned by initiative in 1927. Traps were banned as well. Canner pressure led to the reinstatement of traps and drag seines in the lower river, even after Washington State voters (1935) outlawed traps, fish wheels and seines, owned primarily by the canneries. The Washington initiative passed in the context of a battle between increasingly organized labor and Puget Sound canneries financed by out-of-state capital. In the short term, the major gainers from the gear wars on the Columbia River were the Indian dipnetters at Celilo Falls (Smith, 1979, 95-96).

Gill net fisheries were banned in Oregon's Willamette River by a sports anglers' initiative in 1918. Although they achieved temporary success in banning angling on the Rogue in 1910 and succeeded in banning gillnets on the Nestucca in 1927, they were not successful in completely banning gillnetting on coastal rivers until the 1940s. In contrast to Washington's coastal rivers and bays, where gillnetting is still permitted, Oregon's coastal fisheries were much more accessible to population centers in Portland and Salem, and were frequented by an increasing number of anglers in the economic upswing after WWII (Taylor, 1998a).

The states all taxed fish landings by 1925, marking the beginning of the fish ticket system. Harvest data became more reliable from then on, both in terms of volume and species attribution (Ortmann, 1976).

State and federal fisheries managers, canners and fishers were all aware that most Pacific Northwest salmon runs were in decline by the 1930s (Figure 3.20). A variety of approaches were taken to address the declines without limiting commercial harvests. Sports angling licenses were required in Idaho, and several rivers were closed to sports angling in Oregon. Washington banned the commercial sale or take of steelhead, and closed many rivers as steelhead nursery areas (Ortmann, 1976). A variety of proposals were made for salmon reserves, through the initiative and planning processes in Oregon, and by the Washington Supervisor of Fisheries. None of the salmon reserve proposals made it past the design stage (Lichatowich, 1999, 138-139). Lastly, both the US Fish Commission and the states continued to advocate hatcheries as a technological alternative to clean water and quality freshwater salmon habitat, and over 50 hatcheries were releasing Pacific salmon and steelhead in the Pacific Northwest states by 1930 (Lichatowich, 1999, 143).

The major effect of the Great Depression on Columbia River fisheries was the boost it gave to an ambitious program by the Army Corps of Engineers (ACOE) to build a series of multiple use dams on the river for irrigation, flood control, navigation and hydropower. Appropriations were granted for Bonneville and Grand Coulee dams as emergency public works projects, to draw unemployed victims of the Dust Bowl in the Midwest to the Columbia Basin to create an economy based upon irrigated agriculture and inexpensive hydroelectricity (Cone and Ridlington, 1996, 98-99). The U S Bureau of Reclamation (BuRec) also became active in the Columbia River at this time and its largest dam, the Grand Coulee, blocked over one thousand miles of salmon habitat when it was completed (1938).

The Depression also spelled the end of the contract labor system for cannery workers on the Columbia River, because of increased unionization. The Puget Sound canneries had already shifted to the local Euro-American labor pool among farm families at the turn of the century (Friday, 1994).

In light of the Army Corps of Engineers' ambitious construction program, in 1934 the US Congress mandated that the ACOE cooperate with the Bureau of Fisheries and the states regarding damage to fish and wildlife. The Mitchell Act (1938) laid out the framework for cooperation. The Mitchell Act authorized the Secretary of Commerce and the Bureau of Fisheries to establish hatcheries, conduct studies, implement stream improvements and carry out other salmon conservation activities in the Columbia River basin. Although dam construction proceeded apace, the state-federal program for salmon conservation was not fully developed until after WWII. Congress created the Bonneville Power Authority to manage the hydroelectric power produced by the ACOE's and BuRec's Columbia River dams in 1937 (Cone and Ridlington, 1996, 103-105).

In the late 1930s, both Oregon and Washington legislatures commissioned special committees to investigate the Columbia River salmon fisheries and the effects of the federal dam construction program. The Oregon Planning Board (1938) and Washington's Columbia River Fisheries Interim Investigative Committee (1943) recommended the creation of broad interstate compacts (including Idaho and California) to regulate Columbia River salmon harvests, modeled on the International Pacific Salmon Commission. However, the idea was not politically viable at the time (Lichatowich, 1999, 183-186).

A coalition of fisheries biologists, including the new Fisheries and Wildlife Service in the Department of Interior, unsuccessfully pleaded for a moratorium on Columbia River dams in 1945 on the basis of the cumulative effects on salmon populations. The coalition also included state fisheries agencies, state legislative committees, harvester organizations, cannery associations, labor organizations, and tribal organizations (Lichatowich, 1999, 270). The Corps of Engineers' response was that the fisheries science was inconclusive, and the dams represented many other quantifiable values. Fisheries management agencies shifted their focus away from opposition to mitigation and scientific studies (Mighetto and Ebel, 1994).

While heated battles were being fought in the Columbia River basin, harvesters and canners continued to incorporate technological innovations and to generate substantial harvests, particularly during WWII. The overall harvest trend in the Columbia Basin during the interwar period is one of decline, but harvests during the first two years that the United States was in the war rivaled those of the 1920s (Figure 3.20). Just prior to the war, brine refrigeration had been introduced to the fishing fleets. The innovation facilitated the development of a tuna fishery, operating offshore. Oregon and Washington trollers discovered that they could efficiently capture coho and chinook salmon from April to June on their feeding grounds, then shift to albacore from July to September (Smith, 1979, 87). The troll fishery, intercepting immature coho and chinook, continued to grow in numbers and became an increasingly large problem, as it operated outside state waters and thus could not be regulated by the states (Lichatowich, 1999, 111).

3.5.5 1947-1975

By the late 1940s, it was evident that increased cooperation between the states was needed to manage the fisheries as well as the fish hatcheries. The Pacific Marine Fisheries Commission was one of three fisheries commissions created by interstate compact and approved by Congress (1947-49) to coordinate fisheries regulations and research among states regarding species such as salmon, swordfish and striped bass. The primary concern of the Pacific Marine Fisheries Commission was the salmon troll fishery operating beyond state waters. Commission members appointed by the states of Washington, Oregon and California met regularly to develop recommendations for coordinated fisheries management. The Commission's mandate and funding base changed substantially in the late 1970s after the passage of the Fisheries Conservation and Management Act.

The marine charter fleet and the individual sports fishery grew dramatically after WWII with the development of affordable, safe small boats and the increase in public boat launch facilities in the 1950s. Americans had more income and leisure time, and many spent that time marine sports fishing or angling for salmon and steelhead on rivers and streams (Phinney, 1976, O-4).

The downward trend in harvests in the Columbia River basin was particularly notable after the 1948 season, attributable to a major decline in chinook harvests (Figure 3.19). The decline may be attributable to the completion of the Grand Coulee Dam in 1941. The high-head dam lacked fish passage, consequently blocking access to a great deal of fall chinook spawning habitat. It may also reflect limitations imposed upon the troll fleet after the creation of the Pacific Marine Fisheries Commission (1949).

A 1946 amendment to the Mitchell Act removed appropriations caps for mitigation, and permitted the use of state facilities to implement the Act. States could now receive funds to build or operate hatcheries as part of the federal mitigation program. Idaho, Washington and Oregon concluded the Tri-State Agreement in 1948, to collaborate on salmon conservation pursuant to the Mitchell Act under the Lower Columbia River Fisheries Development Program (LCRFDP). The Program, intended to supply the river and marine commercial fisheries with additional salmon, was initially designed to be much broader than just hatcheries. The states and the Fish and Wildlife Service were to partner in a six-part effort to: 1) remove obstructions to salmon migration; 2) address water quality problems; 3) screen water diversions; 4) transplant salmon stocks from above McNary Dam to the lower river; 5) renovate and enlarge the basin's hatchery system, and 6) create salmon refuges in the tributaries below McNary Dam.

Salmon refuges were controversial, with many viewing the concept as in contravention to states rights. Although the Oregon legislature was split with regard to a Deschutes River refuge, Oregon voters passed an initiative declaring the

Deschutes a "wild river." Oregon sought to block Federal Power Commission approval of Pacific Gas & Electric's Pelton Dam on the basis of its wild river status. However, the US Supreme Court ruled that Oregon did not have authority to block the license to Pacific Gas & Electric, in *Oregon v. Federal Power Commission* (1955) (Anonymous, 1955). Despite legislative support in Washington State, efforts to create refuges were overturned by the Washington Supreme Court. Hatchery development quickly became the dominant component of the LCRFDP, and received the lion's share of the appropriations (Lichatowich, 1999, 191-2).

In 1956, the Fish and Wildlife Service was split into two Bureaus, one for Commercial Fisheries and the other for Sport Fisheries and Wildlife. The Fish and Wildlife Coordination Act was amended in 1958 to require the Corps of Engineers to give equal consideration to fish and wildlife conservation among other planning objectives. The new mandate likely redirected additional funds to salmon passage studies, but certainly did not forestall continued dam construction.

Fisheries legislation and ocean policy were not a high priority in Congress. However, Sputnik and the space race had its counterpart in the ocean science community, in the rush to build blue-water research vessels capable of working on the high seas. The United Nations sponsored Law of the Sea negotiations began in 1958, raising new questions about jurisdiction over coastal resources. A coalition of academics and government employees spurred congressional debates regarding the federal role in ocean policy and research, seeking to develop a coherent US ocean strategy. The policy outcome was never achieved, but the federal bureaucracy was reorganized to combine several marine and coastal programs into one agency, the National Ocean and Atmospheric Administration (NOAA). The coalition had hoped to create an independent agency, but the compromise was to house NOAA in the Department of Commerce (Wenk, 1972).

The Bureau of Commercial Fisheries was moved to NOAA upon its creation in 1970, while the Bureau of Sport Fisheries and Wildlife remained in the Department of Interior. Both entities have subsequently been renamed, as the National Marine Fisheries Service (NFMS) and the Fish and Wildlife Service (FWS), respectively. The

NMFS has jurisdiction over commercial salmonids, while the FWS is responsible for all other salmonids. NMFS and the US Fish and Wildlife Service share responsibility for the Mitchell Act hatcheries designed to augment commercial fisheries. The Fish and Wildlife Service also administers several federal grant programs that provide funding for sports-related activities in state fisheries agencies, including hatcheries. In the 1960s, considerable advances were made in the understanding of salmon physiology and hatchery technology. Fishery biologists proved that the typical hatchery feed consisting of offal was infecting salmon with diseases such as bacterial kidney disease and tuberculosis, and adversely affecting their metabolism. New forms of dry feed were developed that were far superior. Changes were made in hatchery facilities, as understanding of the smoltification process improved and managers learned more about water quality and optimum rearing density requirements. Release times were optimized, to maximize the survival of hatchery releases. Return rates from Pacific Northwest hatcheries increased in the 1960s, and increased coho landings attracted more harvesters to the fishing fleets (Figures 3.19 and 3.20). Many new hatcheries were built by the states to increase the supply of harvestable fish. Unfortunately for fishers and managers, the increase in hatchery returns was related as much or more to beneficial coastal ocean conditions as to improvements in hatchery technology. When a shift occurred in the North Pacific climate regime around 1976, salmon returns fell dramatically (Pearcy, 1992; Lichatowich et al., 1996, 10-11).

Steelhead was proclaimed a game fish in Oregon by voter initiative in 1974. Steelhead sales were henceforth prohibited. The sales ban extended to treaty tribes as well, although the tribes were still allowed to fish for steelhead for commercial and subsistence use. Any tribal sales of steelhead on the Columbia had to be made through fish brokers, who were required to sell the fish outside of Oregon (Weaver, 1997, 5).

3.5.6 1976-2000

Since 1976, salmon harvests in the Pacific Northwest states have declined, with the exception of a brief period in the mid-1980s (Figure 3.20). Harvests of chinook and coho in the region rebounded from 1985-1989, but plummeted once again thereafter and are now at all-time lows. Washington's average commercial salmon landings are presently eight times those of California and Oregon, because of the availability of chum, sockeye and pink salmon in Washington waters. Oregon harvests consist primarily of chinook and coho, California's of chinook salmon. In recent years, California's chinook harvests have outpaced Oregon's (Hare et al., 1999). Roughly half of the total commercial harvest is now taken by tribal fishers.

With the passage of the Magnuson Fisheries Conservation and Management Act (MFCMA; 1976), the federal government at last entered directly into fisheries management through the creation of conservation standards and a series of eight regional Fishery Management Councils. The legislation extended the United States' Fishery Conservation Zone from nine to 200 nautical miles, and utilized language from the ongoing Law of the Sea negotiations to create a framework for permitting foreign fisheries within the US zone.

The Councils were to develop plans for commercial and recreational fisheries operating within the 3-200 mile Fisheries Conservation Zone, for species that required conservation. The Pacific Fishery Management Council (PFMC) developed a Salmon Plan for federal waters along Washington, Oregon and California in 1977. The Councils, comprising representatives of the federal and state governments, the commercial and recreational fishing industries and the public, also develop annual harvest regulations for the fisheries under their purview.[19] Both the plans and the harvest regulations must be approved by the Secretary of Commerce and published in the Federal Register in order to take effect (Rutter, 1997, 365-366).

On the basis of the PFMC Salmon Plan, the Council manages coho and chinook sports and commercial ocean fisheries beyond state jurisdiction. Washington, Oregon, California and the treaty tribes manage fisheries for the same species and monitor escapement within state waters. In order to coordinate coho and chinook harvest management and conservation among all of the players, the "North of Falcon

[19]Per the 1996 Amendments to the MFCMA, the Pacific Fishery Management Council also has one federally appointed treaty tribe representative among its membership.

process" developed in the mid-1980s. State, tribal and federal fisheries managers meet in a series of public sessions in the spring to coordinate proposed harvest plans to the greatest degree possible prior to the PFMC meeting, when the annual harvest plan is approved. Pink, sockeye, chum and steelhead are managed cooperatively according to regional management plans developed by the states, tribes, and federal fishery managers pursuant to major court decisions -- *Hoh v. Baldrige* Framework Management Plan, Puget Sound Salmon Management Plan, and the Columbia River Fisheries Management Plan (Rutter, 1997).

After the passage of the MFCMA, the National Marine Fisheries Service pressured the states to limit entry to the salmon fisheries as a conservation measure. Washington proclaimed a moratorium on new salmon vessel licenses in 1974, and designed a vessel buy-back program. Oregon did not limit entry into the ocean troll and Columbia River gillnet fishery until 1979. Oregon participated in a state-run, federally-funded vessel buy-back program authorized by the Salmon and Steelhead Conservation and Enhancement Act of 1980, beginning in 1983 (Buck, 1986). California enacted license limitation in the salmon fisheries in 1979. Initial license issuance rules were very liberal in all three states (Rettig, 1984, 241-242).

The other event that reshaped the fisheries in the 1970s was the intervention of the federal courts into salmon allocation, on the basis of Indian treaty rights. Judge Boldt's 1974 decision allocating 50% of the salmon available for harvest to treaty tribes immediately reduced the value of non-tribal fishing vessels and increased the standing of treaty tribes with regard to salmon management. Intertribal organizations were formed in the late 1970s to coordinate tribal participation in the Pacific Fisheries Management Council, Columbia River and state allocation processes and to provide fisheries expertise to the tribes. The largest tribal fisheries organizations are the Northwest Indian Fisheries Commission (Puget Sound and Northwest Washington coastal tribes) and the Columbia River Inter-Tribal Fisheries Commission.

In the aftermath of the Boldt decision, the treaty tribes and state fisheries managers worked together to increase the pool of salmon available for harvest, by helping to frame the new oversight process for basin hatcheries and habitat restoration.

Together, the tribal and state managers lobbied to insert strong fish, wildlife and habitat language in the federal Pacific Northwest Electric Power Planning and Conservation Act of 1980. More commonly known as the Northwest Power Act, the legislation created an interstate compact among Washington, Montana, Idaho, and Oregon to better plan and manage the hydroelectric resources of the Columbia River Basin. Fish and wildlife were to be on an equal footing with electric generation in the new Northwest Power Planning Council's (NPPC) multi-resource planning (Lee, 1993).

The Northwest Power Planning Council became the regional forum for bargaining regarding seasonal flow shaping of the Columbia River to maximize both hydropower and fisheries benefits. The NPPC is responsible for the development of basin-wide fisheries and wildlife plans to improve salmon runs and salmon habitat, but the Council has no fisheries management authority. Forest harvest regulations, federal land management and state water law are likewise outside its purview. In practice, the Council has become a forum for allocating Bonneville Power Authority funds for fish and wildlife research, habitat restoration and hatchery mitigation efforts in the Columbia River Basin, alongside previous coordinating entities such as the Columbia Basin Fish and Wildlife Authority. Neither the treaty tribes nor the federal fishery managers have a formal seat at the NPPC table. The Northwest Power Planning Council role in water budgeting and flow shaping became increasingly politicized in the aftermath of Endangered Species Act listings in the Columbia Basin in 1992 (see Chapter 5).

The Pacific Fisheries Management Council's salmon management process was altered with the entry into force of the Pacific Salmon Treaty (PST) in 1985 (see Chapter 8). The Treaty created the Pacific Salmon Commission and a series of joint technical committees to rebuild and allocate shared Pacific salmon stocks in an equitable manner. The Commission was to meet three-four times annually to negotiate harvest management arrangements for the following year for shared chinook, coho, sockeye and pink salmon fisheries. Thus the Pacific Salmon Treaty created a new allocation process, one hierarchical level above the PFMC. Beginning in the late

1980s, the Pacific Fisheries Management Council's starting point for allocation was the US harvest share negotiated under the Pacific Salmon Treaty (Rutter, 1997).

By 1993, salmon harvests in California, Oregon and Washington were so small, that the states requested disaster relief unemployment insurance from the federal government (Figure 3.20). Congress created the Northwest Emergency Assistance Plan, a two-year program providing salmon habitat restoration jobs, creating "test" or data-gathering fisheries, and funding an additional Washington state fishing license buy-back program to reduce excess commercial and marine recreational harvest capacity. No further buy-back programs have been developed in Oregon. Most gillnetters appear to have adopted strategies of fishing in other areas or for different species, or by taking another job. Given that many gillnetters are 3rd and 4th generation fishers, few have left the fishery entirely (Gilden and Smith, 1996).

CHAPTER 4 CLIMATE VARIABILITY

The literature regarding the effects of climate variability on North Pacific salmon abundance has developed rapidly over the past three decades. The Russian literature predates North American discussions about the interactions of climate and fisheries productivity in the North Pacific, because of the centralized nature of the Soviet fisheries and oceanographic research system, supporting applied research for the development of high seas fisheries.

4.1 Historical Review of the Climate-Fisheries Literature for the North Pacific

Russian oceanographers began studying the Northwest Pacific using a systems approach in the early 1960s. By the early 1970s, Russian oceanographers had recognized that there were alternating warm and cold states for the water mass on the Kamchatka shelf. Davydov (1984) published the first broad synthesis of data regarding the atmospheric forces driving differences in ocean conditions, documenting the correlation of climate phases with cycles in herring and pollock abundance, and hypothesizing an eleven-year phase duration. He hypothesized that climate phases are driven by variability in solar activity. The current Russian leader in fisheries-climate research is L. B. Kliashtorin, based at VNIRO in Moscow. Kliashtorin's work further develops the association between cycles in fishery productivity and variability in solar activity, as characterized by the Atmospheric Circulation and the Earth Rotational Velocity indices (Kliashtorin and Sidorenkov, 1996). Some Russian authors boldly conclude that salmon population variability is driven solely by marine and freshwater environmental variability, and is not influenced by harvest effort (Radchenko and Rassadnikov, 1997).

Early North American research focused on environmental factors affecting regional fisheries recruitment in the California Current. In the mid-1980s, a new generation of research was spurred by the convergence of the increased availability of synoptic oceanic and atmospheric data, improved techniques for non-parametric statistics, a severe El Niño event in 1982-83, and declining salmon populations in the contiguous United States and British Columbia. Early North American research examined the role of climatic variability with a periodicity of five to seven years, primarily the El Niño-Southern Oscillation (e.g., Nickelson, 1986).

Bering Sea groundfish studies in the late 1980s produced evidence for alternating average conditions or states characterizing biomass productivity (Hollowed and Wooster, 1992). Salmon researchers at the University of Washington followed Hollowed and Wooster's lead, and produced a series of papers developing new indices to describe large scale ocean-atmosphere variability (Mantua et al., 1997) and correlating salmon production trends with climate variability (Francis and Hare, 1994; Hare et al., 1999). The pivotal article published in fisheries journals during this period was "Pacific Salmon Production Trends in Relation to Climate", authored by Canada Department of Fisheries and Oceans researchers Beamish and Bouillon (1993). The latter article demonstrated the correlation of an index of the intensity of the winter Aleutian Low Pressure system (ALPI) in the North Pacific to total harvest trends for North Pacific sockeye, chum and pink salmon.

Several other researchers subsequently reported correlations between historical trends in salmon abundance and variations in the intensity of the winter-spring Aleutian low pressure system (Hare, 1996; Hare et al., 1999; Mantua et al., 1997) and analyzed the temporal variability of North Pacific climate attributes (Minobe, 1997; Ware, 1995; Ingraham et al., 1998). The observed 20-30 year alternation of climate states in the North Pacific is referred to as the Pacific Decadal Oscillation (Mantua et al., 1997; Hare et al., 1999).

Annual and special PICES and North Pacific Anadromous Fish Commission (NPAFC) meetings have brought fisheries biologists, climatologists and oceanographers together for the past few years to discuss and review the growing evidence for both direct and indirect effects of climate upon salmon production (e.g., North Pacific Anadromous Fish Commission, 1998). Japanese stocks appear to respond almost in phase with Alaskan catches (Heard, 1998, 6). Russian pink salmon stocks respond similarly, but may experience a higher frequency oscillation in climate-production states (Krovnin, 1998, 14).

Climate-productivity linkages are not disputed, but there is much yet to be determined about the causal mechanisms and the finer regional scale variability of climate effects upon salmon production. Some analysts have perceived a simple oscillation of climate states, correlating alternately with periods of high salmon production in Alaskan and in the American Northwest (e.g., Hare et al., 1999). Others believe there may have been an additional regime shift in the late 1980s or early 1990s, without clearly discernible favorable or unfavorable effects (North Pacific Anadromous Fish Commission, 1998, 49). Perhaps the confusion is a matter of metrics and scale, which will be sorted out as researchers develop a common fisheries-climate paradigm over the next few years of focused research.

4.2 Historical Periods Derived from the Climate Literature

In order to discriminate the effects of climate variability from other effects on salmon harvest trends and salmon management philosophies, historical narratives are subdivided by time period in accordance with the literature on interdecadal climate variability (Ware, 1995; Minobe, 1997; Taylor and Southards, 1997; Ingraham et al., 1998; Hare et al., 1999). The time periods consist of six two to three decade periods of alternating cool and wet versus warm and dry conditions in the Eastern North Pacific (Table 4.1). A cool phase of the climate cycle is considered to be favorable for salmon production in the American Northwest, but not in Alaska, Russia or Japan. A warm phase of the climate cycle is considered favorable for salmon production in Alaska, Russia and Japan, but not in the American Northwest (Mantua et al., 1997; Hare et al., 1999).

4.3 Salmon Fisheries Management Implications of Climate Variability

Several researchers have written articles about the policy implications of climate variability for fisheries management. Lawson's (1993) "Cycles in ocean productivity, trends in habitat quality and the restoration of salmon runs in Oregon" was the first to call attention to the extinction pressure created by the combination of cyclical

Table 4.1. Time periods utilized in the dissertation and their correspondence with the climate variability literature. The first two climate periods are based upon Minobe (1997) and the last four periods upon Taylor (1997). [a]Taylor used air temperature and precipitation data for the Oregon coast (1997). [b]Minobe used six time series, representing sea surface and air temperature at locations varying from the Indian Ocean to Western North America, sea level pressure measurements from the Central North Pacific, and reconstructed Western North American air temperatures based upon tree ring data (1997). [c]Hare and colleagues used sea surface temperature anomaly indices characterizing the El Nino-Southern Oscillation and the Pacific Decadal Oscillation, as well as an index characterizing the intensity of the December-March Aleutian Low (Hare et al., 1999). [d]Ware used Western North American air and sea surface temperature and wind stress data (1995).

Climate periods in this study	**Taylor (1997)[a]**	**Inferred conditions in the Eastern Pacific**	**Minobe (1997)[b]**	**Hare et al. (1999)[c]**	**Ware (1995)[d]**	**Inferred conditions in the Eastern Pacific**
Pre-1870					1850-1860 1861-1868	warm cool
1870-1896			1870-1889		1869-1871 1872-1884 1885-1888	warm Cool warm
1897-1914	1896-1914	wet and cool	1890-1924		1889-1897 1898-1906 1907-1922	cool mixed cool
1915-1946	1915-1946	dry and warm	1925-1947	mid-20s to mid-40s	1923-1947	warm
1947-1975	1947-1975	wet and cool	1948-1976	mid-40s to 1976	1948-1956 1957-1967 1968-1977	cool warm cool
1976-1998	1976-1998	dry and warm	1977-	1977-	1978-	warm

variability in marine habitat quality and declining trends in freshwater habitat. He warned that if freshwater habitat quality continued to decline, many stocks would face extinction even if wise harvest decisions were made. Lawson also argued for a long time horizon for freshwater habitat restoration projects, as cyclical variability in marine rearing conditions and improved short-run salmon runs would likely reduce political support for freshwater habitat restoration.

Historian Joseph (Jay) Taylor (1998a) used contemporary knowledge regarding El Niño events to reinterpet historical explanations for salmon run failures and successes in Oregon. He attributed significant salmon run failures in 1877 and 1926 to El Niño events, whereas at the time they were attributed to overfishing. The 1877 failure of the salmon run galvanized political support for hatchery culture of salmon as a non-restrictive, technological means to assure bounteous fish, and a strong salmon run in 1883 convinced many that hatcheries were effective. Subsequent climate-related increases in run strength occasionally coincided with hatchery programs, reaffirming the technological approach to salmon management. The timing of the 1926 El Niño event fueled a successful sport fishing initiative to eliminate commercial gillnetting in Oregon's coastal streams. Taylor (1998) cautions that most histories of salmon decline suffer from political bias and oversimplification.

In "Decadal climate cycles and declining Columbia River salmon" (1999), Anderson used cyclic marine habitat conditions to argue for status quo hydropower system management on the Columbia River. He noted that the initial effects of hydropower development upon salmon runs in the Columbia River basin were masked by the upturn in marine survival for Pacific Northwest salmon runs in the late 1940s. Marine survival conditions worsened in the late 1970s and persisted at least through the time of his analysis. Anderson argues that hydropower system mitigation programs undertaken during the past twenty years cannot be fairly evaluated because of recent unfavorable marine survival conditions. He concluded that it was premature to abandon salmon transportation programs. By extension, it is premature to adopt natural river policies costly to the Bonneville Power Association, the funder of Anderson's research, such as flow shaping through altered hydropower practices, or the breaching of the Lower Snake River dams. While the imprecation to take ocean conditions into account when evaluating salmon recovery strategies is a wise one, it ignores the cumulative effect of low but significant juvenile and adult salmon mortality caused directly or indirectly by transportation and passage through the hydropower system during periods of low ocean survival. Distinct wild salmon and steelhead populations may be extinct before we learn whether the transportation approach is successful during a period of favorable marine conditions.

4.4 Biological Implications of Climate Change

Recent research by Dr. David Welch indicates that climate change, in the form of global warming, is likely to move the ocean distribution of most salmonids northward. Global warming would also likely affect freshwater life history stages of salmon reproduction (Welch, 1992, 37). Collaborative Canadian-Japanese research suggests that steelhead and sockeye salmon distinct, seasonally variable temperature preferences for ocean rearing, and that the area available for steelhead ocean rearing would be reduced and shifted northward as a result of a hypothetical doubling in global carbon dioxide levels (Welch et al., 1998, 403).

CHAPTER 5 SPECIES COMPOSITION, HABITAT ALTERATION AND ENDANGERED SPECIES LAW

5.1 Species Composition by Jurisdiction

The current species names for six of the seven *Oncorhynchus* species are derived from Georg Steller's descriptions during a Russian expedition to the Kamchatka Peninsula (1738-1744), and thus bear either Russian or indigenous colloquial names: sockeye-nerka, coho-kisutch, chum-keta, chinook-tshawytscha, pink-gorbuscha, and steelhead-mykiss or mikizha (Stearley and Smith, 1993, 4). Masu, the species name for cherry salmon, is Japanese in origin.

The principal commercial species for Japan and Russia are chum and pink salmon (>80% of annual harvest), respectively.[20] Canada's and Alaska's principal commercial species are pink (>50%) and sockeye (>20%), respectively. Chinook and coho are the principal commercial species that spawn in the American Northwest, but their relative contribution to the fisheries has varied significantly over time. During the favorable ocean rearing regime in the 1970s, the 1975 Pacific Northwest harvest was composed of coho (40%), chinook (26%), sockeye (17%), pink (15%), and chum (2%). During unfavorable ocean rearing regime in the 1990s, the 1995 harvest was composed of pink (44%), chinook (26%), chum (12%), coho (10%) and sockeye (6%). Pink salmon do not contribute to harvests at all in even year fisheries, because there is not an even year run in the region. Harvest rates in the Pacific Northwest do not reflect the relative contribution of US rivers, because the majority of the sockeye and pink salmon harvested in the jurisdiction originates in Canadian waters. Figure 5.1 depicts the relative species composition of the five jurisdictions, with the dotted line indicating minor contribution.

[20] The percentages refer to the proportional representation of the species in the commercial catch of each country or state, counted in numbers of fish. These percentages are based on 1994 harvest data, but are representative of overall catch composition.

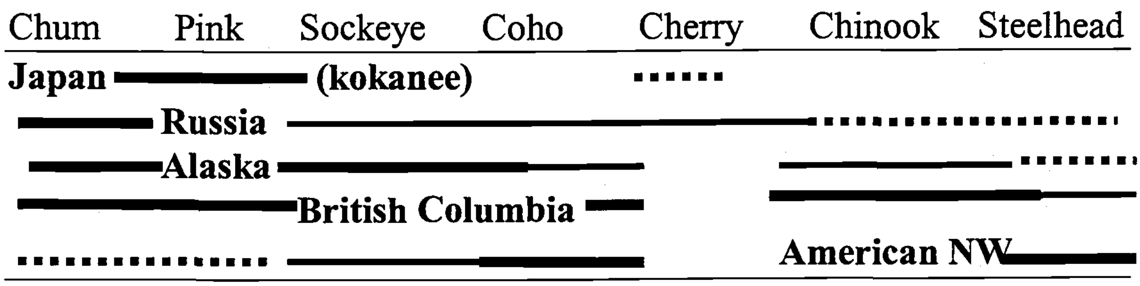

Figure 5.1. Relative species composition of salmon in the five jurisdictions.

Because of differing biology by species, the major commercial salmon runs in each jurisdiction have varying exposure risks associated with habitat alteration (Figure 5.2).

Pink salmon are typically the least vulnerable, because they use freshwater for spawning only. In Russia, pink salmon may use spawning gravels throughout a river basin if the population is large. In the Pacific Northwest and British Columbia, pink salmon tend to utilize the lower reaches of river basins. Summer-run chum salmon (throughout the North Pacific) spawn in lower reaches of river basins. Fall-run chum salmon (Asia and Alaska only) are at higher risk than pink salmon because of long migration passages to upstream spawning grounds in third- and fourth-order tributary streams. Chinook salmon are at greater risk to habitat alteration, as they not only migrate far upstream to spawn, but spend from several months (ocean-type chinook) to a year or more (stream-type chinook) in freshwater habitat. Coho fall somewhere between fall chum and chinook – their migrations are shorter, but they spend at least one year rearing in freshwater. Sockeye salmon face the highest risks, as they have long inland migrations, spend one to three years in freshwater, and require specific lacustrine habitats to spawn and rear.

<table>
<tr><td colspan="6">All species require adequate water quality, water quantity, and appropriate spawning gravels at the right season and location</td></tr>
<tr><td colspan="2">Spawning habitat needs only</td><td colspan="4">Freshwater spawning and rearing habitat needs</td></tr>
<tr><td colspan="3">Not good jumpers</td><td colspan="3">Good jumpers</td></tr>
<tr><td>Pink</td><td>Chum*</td><td>Coho, Cherry</td><td>Chinook</td><td>Sockeye</td><td>Steelhead</td></tr>
<tr><td colspan="2">No passage obstacles</td><td colspan="4">Face passage obstacles because of length of migration (anthropogenic barriers, elevated water temperature, lack of resting habitat, slack water, predators)</td></tr>
</table>

Figure 5.2. Relative vulnerability to habitat alteration by species. Based upon Groot and Margolis (1991). *The Russian literature on chum recognizes two distinct races, fall and summer chum, with different run timing, spawning locations, and life history characteristics. Fall chum typically make much longer spawning migrations than summer chum, thus facing multiple passage obstacles. Summer chum face few to no passage obstacles. Due to the long juvenile migration, fall chum may feed for two-three months in freshwater before reaching the ocean (Gritsenko et al., 1987).

The biology of the predominant Western Pacific salmon species (pink and chum) also makes them the easiest species to rear artificially in hatcheries, as they do not need to be held for long periods to rear. Most of the wild salmon (Figure 5.1) in Japan, Russia and Alaska are relatively easy to rear artificially. They are also easier to harvest, as they are schooling species. Coho, cherry, chinook, sockeye and steelhead are all reared in a hatchery setting for several months prior to release as smolts, with exacting needs in terms of water quality, temperature, feed, hygiene, etc.

5.2 Salmon Habitat Alteration

The five salmon jurisdictions differ greatly in the extent and quality of Pacific salmon habitat, both because of geography and anthropogenic changes to the environment. Most salmon rivers in the Western Pacific have monsoon- and monsoon continental climates, dominated by late summer peak flow and a secondary snow-melt peak in the spring. Low flows are in January and February. On Hokkaido and Sakhalin, spring snow-melt peak flows are dominant, and monsoon-generated peak flows are secondary. Salmon rivers in the Eastern Pacific range in peak runoff timing from winter in the south (much of California) to late summer in most of Alaska. In the US Pacific Northwest and British Columbia spring peak flows predominate, with a secondary peak in the fall.

Salmon stocks in the more continentally-influenced mainland basins of the Western Pacific (e.g., Amur River, Sea of Okhotsk littoral) are particularly vulnerable in low-snow years. In the absence of snow, there is no insulation for spawning gravels and many redds freeze. In contrast, the greatest weather-related risk in the more continental, interior Columbia River and the Sacramento-San Joaquin basins is high late summer temperatures, exacerbated by low flows because of water withdrawals for irrigation. Pacific salmon are cold water fishes, and generally have a low tolerance for water temperatures greater than 16° C (Beschta et al., 1987, 219).

Human population density is a good surrogate for human effects on Pacific salmon habitat; salmon stocks are in the worst condition in areas with high human populations. Table 5.1 depicts the present and future projected populations of the four Pacific salmon countries.

Table 5.1. Present and projected populations (Japan, Russia, Canada and the United States). Current and projected population in thousands. Source: Population Reference Bureau (1999).

(in 000s)	Japan	Russia	Canada	United States
1999	126,745	146,519	30,589	272,505
2025	120,913	138,092	39,165	335,100
% change	-5	-6	28	23
1997 per capita GNP	38,160	2,680	19,640	29,080
Population per km^2 (1999)	335	9	3	29

Among the salmon-producing regions of these countries, Hokkaido and the American Northwest are the most densely settled (Table 5.2). Population projections were not available for Hokkaido or the Russian Far East Economic Region. Populations in both regions are likely to decline over the next 25 years, although at a much slower rate in Hokkaido than in the Russian Far East. The rapid Russian decline is because of a combination of increased mortality, a decline in the birth rate, and outmigration to western regions of Russia. Nationally, the Russian population declined 2% between 1990 and 1999 (Iablokova, 2000).

Human populations are not spread uniformly across landscapes, but are aggregated where climates are more hospitable to agriculture and daily living, often in large river valleys and in coastal zones. Thus there is differential human stress on salmon rivers with a decreasing gradient from south to north, as climates become less hospitable to humans. The south to north gradient in arable land also drives the search for water resources for hydroelectricity and irrigation, as well as water supplies for industry and urban populations. Fewer rivers are dammed above 50 degrees north latitude, given the lower demand for hydropower and irrigation.

Table 5.2. Present and projected population of salmon-producing regions around the North Pacific. Current and projected population in thousands. [a]Data year; [b]1995; [c]1998; [d]1999; [e]1999; [f]1999. Sources: B. C. Stats (1999a); Motrich (1995); U. S. Census Bureau (1999); U.S. Census Bureau (1999); Japan Statistics Bureau (1999); B. C. Stats (1999b); National Geographic Society (1995); Gosudarstvennyi komitet statistiki (1999).

(IN 000S)	Hokkaido	Russian Far East	BRITISH COLUMBIA	Washington-Oregon-California-Idaho	Alaska
Population[a]	5,692[b]	7,300[c]	4,046[d]	43,565[e]	620[f]
2025	not available	not available	5,868.7	62,959	885
% change	not available	not available	45	45	43
Density, per km^2	68	1.3	0.4	41.3	0.4

Given that the majority of the population in each Pacific salmon-producing region lives within the coastal river drainages, the potential for increasing negative effects on salmon habitat and salmon populations as human populations grow is clearly evident.

The remainder of this section summarizes land use history and environmental regulations by time period in each jurisdiction.

5.2.1 Japan

5.2.1.1 Pre-1870

Prior to the development of large contract fisheries in the late 18th and early 19th centuries, there were no major settlements on Hokkaido more than about 12 km inland. Fishing, mining and forestry were the only industries (Howell, 1995, 17).

The introduction of pound traps for herring and salmon harvest prompted an increase in the demand for lumber. Trap pilings were of stout timbers. The greater demand was for fuel to dry herring and pink salmon in order to produce fish meal. Deforestation locally increased erosion in the vicinity of large contract fishing operations (Howell, 1995, 56).

5.2.1.2 1870-1896

Japan's river systems were used as a transportation system for humans and material well into this period. After the Meiji Restoration, the government hired Dutch engineers for advice regarding flood control. Dutch techniques, emphasizing upstream-downstream connectivity fell by the wayside in the face of a series of devastating floods in the 1880s. Railroads began to supplant the need for riverine transportation, permitting the use of hard engineering structures to contain high flows. The most common practice was to construct streamside levees and dams (Nakamura, 1996, 43).

The Hokkaido Development Agency was created in 1870 by the Meiji Government to promote the development of mining, forestry, agriculture, and immigration on Hokkaido. The fishery was viewed as a convenient source of income, but not as an industry of the future. Ninety percent of the Hokkaido tax base was provided by the fishing industry in 1875 (Howell, 1995, 94).

5.2.1.3 1897-1914

Despite the 1873 Land Tax Reform and private sale of land, title became concentrated in few hands by the turn of the century, with tenanted land accounting for

46% of total occupancy. Japan's farmers and fishers became increasingly impoverished during this period, because of the concentration of land and harvest rights ownership in the hands of absentee owners (Takahashi, 1993, 97).

5.2.1.4 1915-1946

The Great Depression deepened the troubles among Japan's farmers, and led to the formation of activist peasant unions. Japan passed several laws in support of small farmers during the 1920s and 1930s, but fell short of passing tenancy requirements because of pressure from landowners (Takahashi, 1993, 98).

5.2.1.5 1947-1975

Land reforms were enacted in Japan in 1946, during the MacArthur Occupation Administration. Reforms created a better-educated class of owner farmers, eliminated social unrest, and freed a large agricultural labor pool for the rapidly industrializing economy. The government purchased the lands of the largest landowners and resold them to individual farmers. Tenanted lands fell to 11% by 1950. Total agricultural land area was also protected, to prevent radical shifts to alternate uses. After WWII, Japan's population made a large shift from rural agriculture to the urban industrial and service sectors. Almost 33% of Japan's population moved to the cities in the 1950s. Urban migration rates slowed considerably in the 1970s, with young people accounting for most of the rural outflow (Takahashi, 1993, 99-102).

In the 1960s, most responsibility for planning and development accrued to the Ministry of Construction. It is responsible, for instance, for implementation of the Sea Coast Law and the River Law. The Ministry is the classification and permitting authority for industrial development and for public works. The apparent objectives of the Ministry are to protect human developments from natural events such as floods and monsoons, and to promote economic development (Koppel, 1993, 46; Geographical Survey Institute, 1977).

Japanese hatchery chum salmon returns increased significantly by the early 1970s, and the existence of hatcheries on particular river systems was used as a rationale to industrialize rivers. Hatchery returns were captured in the estuaries, thus riverine habitat was perceived as unnecessary. Dams were built, rivers were channelized, and water pollution levels increased [Kaeriyama, 1992 #1257, 58].

In 1974, Japan instituted a system whereby private landowners had to seek government permission to harvest a timber unit greater than one hectare in area (Ishii, 1996, 10). Harvests began to decrease at about that time, because of increasing imports. Between 30 and 50% of Hokkaido's forests were planted second growth in the early 1970s, and over 60% of the island was forested. Forest ownership is predominantly private (55%). The remainder is national forest (30%) and public forests (14%) (Geographical Survey Institute, 1977, 150-153).

As in other countries around the North Pacific, several environmental laws came into force in Japan in the late 1960s and early 1970s. The laws include the Basic Law for Environmental Pollution Control (1967), the Marine Pollution Prevention Law (1970), and the Water Pollution Control Law (1970) (Boxer, 1989, 197-198). These laws are considered important to the salmon ranching program in Japan, although it is unclear from the literature whether they affect hatchery operations directly (Matsuda, 1992, 170). The combination of the effects of the first oil embargo (1973) and extended jurisdiction (1976-77) fostered an increased sense of stewardship in Fisheries Conservation Associations, and about a quarter of those polled in the late 1980s were engaged in habitat improvement projects. Most of these were for sedentary rather than migratory resources. Fisheries Conservation Associations have no authority for habitat protection or improvement beyond their boundaries (Hasegawa et al., 1992, 121, 126).

Fisheries are a priority use of Japan's coastal waters. Wigen (1989) believes that much of Japan's heavy industry moved out of the country rather than stay in the Japanese archipelago, where it would have been necessary to buy out Fishery Cooperative Association harvest rights in order to build in coastal areas.

5.2.1.6 1976-2000

Alternate uses of Japan's shorelines and coastal waters have become a problematic and for Japan, an uncustomarily litigious issue. Although the central government may expropriate sea territories and coastal lands for reclamation or industrial development with adequate compensation, private developers must negotiate to purchase such rights from the Fisheries Cooperative Associations at fair market value. Coastal pollution and land use conflicts have become major issues confronting the fisheries sector, particularly on Honshu (Ruddle and Akimichi, 1989, 364).

In urban areas in Japan, stream flows are flashy because of the extent of impervious surface, and flood control is increasingly important as the economic value of industrial and economic structures rises with construction density. Consequently, new concrete embankments are built or river beds are excavated to increase channel capacity during high flow. In less urbanized areas, such as most of Hokkaido, lowlands are now occupied by agriculture, and the uplands are used for industrial timber harvest. The Hokkaido Prefectural Government proposed a greenbelt riparian policy in 1992, with the intent to protect existing riparian corridors and unpaved agricultural lands (Nakamura, 1996, 43, 53-56).

Japanese environmental law requires periodic National Surveys on the Natural Environment. Three river surveys have been conducted between 1979 and 1992 to assess naturalness, alterations, and the state of freshwater aquatic fauna. Wilderness watersheds were also evaluated. According to the 1985 survey, only 13 of 113 Class A (rivers significant to the national economy) were unobstructed or have fish passage facilities. The 1992 survey reviewed Class B rivers (regional importance) and major tributaries of Class A basins, for a total of 153 rivers. The proportion of unobstructed rivers in this group was not reported, but the ratio of natural riverfront vs. artificial riverfront was 73:27 (Japan Environment Information Center, 1999b; Biodiversity Center of Japan, 1999a).

Hokkaido supports most of the salmon production in modern Japan. Population density on Hokkaido in 1993 was 72 people/sq. km., with population concentrated in urban areas. Sapporo, the capital of Hokkaido Prefecture, accounted for 31% of the island's population. Food processing, pulp and paper industries are large components of the manufacturing sector. Forest planning for public and private lands is carried out by the Prefecture. Municipalities have little authority in the forest management process. Hokkaido's steep slopes are prone to landslides and debris flows, thus 36% of Hokkaido's forests are under strict harvest and development limits because of their protective function. Timber harvests in Japan have decreased since 1990, because of economic recession (Ishii, 1996, 6-10).

Japan's environmental laws have been rewritten in the 1990s, to become more comprehensive in dealing with cumulative effects, urban environmental quality, and global environmental problems. The Basic Environmental Law (1993) amends the earlier Environmental Pollution Control Law (1967) and the Nature Conservation Law (1972). The new law defines local, prefectural and central government jurisdiction with regard to environmental management, requires environmental impact assessments, mandates the inclusion of environmental issues in planning processes and creates economic incentives for pollution reduction. It also seeks to improve environmental infrastructure, promote environmental education and access to government information, and increase research and technology development. The Japan Environment Agency is responsible for implementation (Japan Environment Information Center, 1999b).

5.2.2 Russia

The first Russian Far Eastern settlers were the trapper-traders (promyshlenniki) and Cossacks, who accompanied or proceeded official government expeditions. The early settlers in the 17th and 18th centuries congregated in a few small outposts at Okhotsk, Petropavlovsk, and other military posts, but did not have a great effect on the landscape aside from significant depletion of sables and other valued fur-bearers. Peasant migration to the Russian Far East began in the 19th century, and was directed primarily to the Amur River basin and Primorsky Territory (Figure 3.9).

5.2.2.1 Pre-1870

Mid-19th century land reform in Russia led to the first wave of peasant settlement in the Amur River basin. The reformist regime of Alexander II enacted the Emancipation Act of 1861, which created a system of redemption dues for serfs to redeem small parcels of land, freeing 48 million government and private serfs. The small parcels were insufficient for most peasant families to survive on, and the peasants were still obligated to pay poll taxes (Crankshaw, 1976). However, the Act did loosen peasant ties to the land, and for the first time created a market for labor. The Act was followed by an 1861 law, which provided settlement incentives including a 20-year waiver of rent, tax obligations and military service. Overland travel to the Far East was very difficult, and most of the first wave of settlers did not travel further than the Upper Amur River basin (Zolotukhin et al., 1997).

5.2.2.2 1870-1896

The southern Russian Far Eastern population grew rapidly in the 1880s. A government-private schooner and steamboat service called the Volunteer Fleet was subsidized to carry settlers from Odessa to Vladivostok, creating a second wave of settlement. Gold was discovered and mined in the middle Amur and in Manchuria during this period, likely leading to local alterations in stream geomorphology, downstream sedimentation and alteration of water chemistry (Malozemoff, 1958, 13-14).

The Trans-Siberian railway was in the planning stages, and would eventually connect Irkutsk, Khabarovsk and Vladivostok to Moscow and St. Petersburg by rail. Priamurye Governor General Korf expelled most of Primorye's Korean and Chinese residents during the 1880s because of fears of Chinese and Japanese espionage, and labor shortages in some sectors were acute. Thus increasing Slavic settlement was a major policy objective. In 1891, Tsarevich Nicholas, soon to ascend to the throne as Emperor Nicholas II, broke ground on the eastern end of the Trans-Siberian railroad, the Ussuri line to run from Vladivostok to Khabarovsk. By 1896, the western leg of the Trans-Siberian railroad was complete to Irkutsk, on the western shores of Lake Baikal (Chang, 1971). The Ussuri Line between Vladivostok and Khabarovsk was completed by 1897. The remainder of the Trans-Siberian from Irkutsk to Khabarovsk, traversing the rugged territory to the north and east of Lake Baikal, was not completed until 1916 (Marks, 1991).

5.2.2.3 1897-1914

Until 1903, travelers and settlers had to take the railway east as far as Lake Baikal, portage to the headwaters of the Amur, then travel by steamer down river to Khabarovsk. Settlers taking the Chinese Eastern Railway only had to pay one-quarter fare, an additional incentive to move to the east (Gilbert, 1972). The new influx of settlers first occupied lands around Lake Khanka that looked like the steppe lands of western Russia, and then moved into the headwater tributaries of the Ussuri River, displacing the Nanai natives to adjacent river basins further from Vladivostok. Poorly adapted western agricultural practices devastated the forests in many of the headwater valleys (Zolotukhin et al., 1997).

In 1906, Prime Minister Stolypin completed the liberation of Russia's peasantry, freeing them from village communes and making all crown lands eligible for purchase by peasants. The reforms prompted the 3rd, or "Stolypin wave" of Far Eastern settlement, taking advantage of cut-rate fares on the Chinese Eastern Railway (Stephan, 1994).

The Stolypin wave of settlers primarily affected the lands of the southern Russian Far East, as the more arable lowlands had already been settled. The newcomers moved further up the hillslopes, carving homesteads out of taiga. Not knowing how to improve the forest soils with local fertilizers, or how to employ raised bed agriculture to contend with summer monsoon rains, the peasants practiced slash and burn agriculture, moving to new sites when then the old lands were exhausted. The headwaters of the Ussuri River basin were heavily altered by agricultural and forest practices in this period (Zolotukhin et al., 1997).

5.2.2.4 1915-1946

This period encompasses cataclysmic socioeconomic changes in Russia: WWI, the Russian Revolution and Civil War, the Stalinist collectivization drive and WWII. While the Civil War was ravaging for humans, livestock and wildlife, it likely slowed the pace of timber harvest, mining and other land development. The peak landscape alterations likely occurred during the 1930s, as Young Communist Komsomol members worked side-by-side with brigades of prisoners and political exiles to build cities, roads and industrial plants (e.g., the industrial city of Komsomolsk-na-Amure). Exile and prison labor was used to harvest timber on Sakhalin Island, and to mine for gold, minerals and other precious metals throughout the Russian Far East (see, for instance Lincoln, 1994). The Russian Far East experienced the highest rate of population growth in the Russian Republic during the 1930s, doubling its population between 1926 and 1939 without including prison camp (gulag) inmates (Stephan, 1994, 185).

5.2.2.5 1947-1975

The Council of Ministers passed a decree "On measures to strengthen conservation of fish stocks in waters of the USSR", in 1969. In addition to establishing a system of civil fines and providing for criminal prosecution, the law created a compensation system for habitat damage. Monetary damages awarded as compensation for destruction of fish or fish habitat were to accrue to the Territorial divisions of the Federal Fisheries Conservation, Enhancement and Enforcement Agency (Rybvods; Kolbasov, 1974, 42; Volkov and Bekiashev, 1980, 97). In practice, it was nearly impossible to levy criminal penalties for fishing violations or destruction of fish and fish habitat. The compensation system also has a major flaw – all compensation is in the form of one-time, monetary payments to the regional Rybvods. Cumulative effects are not taken into account, and no on-the-ground restoration or mitigation is required. This system is still in effect in the Russian Federation today (Zolotukhin, 1996b).

The 1969 decree was followed by the promulgation of the "Fundamental Principles of Water Legislation of the USSR and Union Republics" in 1970. The "Principles" addressed issues of water quality and quantity, and created a system of permits for economic organizations to conduct certain types of work in waterways. The Territorial divisions of the Federal Fisheries Conservation, Enhancement and Enforcement Agency (Rybvods) were to be among the agencies consulted in the permitting process. Article 26 banned the floating of rafted and unrafted logs on navigable waterways and waterways of significance for fish reproduction. Article 28 required the screening of water intakes at water projects (Volkov and Bekiashev, 1980, 101).

The burden of proof rested with the Rybvods, who were weak agencies relative to the various state-run economic enterprises. Many of these new requirements did not take effect in the Russian Far East until implementing regulations were promulgated by the Ministry of Fisheries jointly with the Territorial divisions of the Federal Fisheries Conservation, Enhancement and Enforcement Agency (Rybvods). Log-rafting bans, for instance, were enacted at various times during the 1970s and 1980s across the Russian Far East. The Rybvods compiled cadastres of salmon and sturgeon spawning rivers of economic importance pursuant to this legislation. The cadastres were subsequently approved by the Council of Ministers in 1973 (Volkov and Bekiashev, 1980, 100).

Large-scale industrial and natural resource extraction projects were undertaken in this period. Clear-cutting is generally not practiced in Russia, but repeated entry selective harvest high-grading desirable species significantly altered forest structure in many areas of Khabarovsky and Primorsky territories and Sakhalin Island. There are few commercial quality timber stands in Magadan and Kamchatka territories (Figure 3.12), thus they were spared large scale vegetation changes. The most significant environmental change agent in Magadan and northern Khabarovsky Territory is mining; many rivers have been substantially altered by dredging operations. Russian law does not require channel or surface soil restoration after industrial mining projects.

Large-scale hydroelectric projects are uncommon in the Russian Far East. The only large hydroelectric facility in existence at present is the Zeya Power Station in the Amur River Basin, built in 1974. The Zeya Dam did not affect anadromous salmon populations, but has severely affected resident salmonids such as Siberian taimen *Hucho taimen* and lenok *Brachymystax lenok*, as well as terrestrial animals (Podolski, 1998, 17). There are also several hydroelectric stations on Chinese tributaries of the Amur River, also presumed to be beyond the range of Amur fall chum salmon in the basin.

Water pollution is an acute but localized problem, primarily in urban areas or near military bases. Russian cities have very inadequate to no municipal sewage treatment plants. The exception is the lower Amur River, where there is severe contamination of sediments with heavy metals, PCBs, and even radionuclides. Bioaccumulation has been noted in resident fishes. More recently, phenol-tainted fish, including salmon, have been a problem. Scientists are in disagreement regarding the source of the contamination, whether a natural by-product of eutrophication or a direct result of Chinese industrial effluent flowing from the Sungari River. Transboundary issues and the current Russian economic situation make these problems particularly challenging (Voronov, 1997, 17-18).

5.2.2.6 1976-2000

Two new laws strengthened Russian environmental management in the 1990s, one just before and one after the collapse of the Soviet Union. The first was the Federal Environmental Protection Law (1991), and the second was the Federal Environmental Review Law (1995). The former law restates jurisdictions and policies regarding environmental quality. The latter establishes a process for environmental review ("ekspertiza") of industrial, municipal and natural resource extraction projects. The process has several shortcomings. It reviews a given project as proposed, measuring it against a set of country-wide criteria and standards, without taking temporal or spatial cumulative effects into account. There is no provision for public participation, and no assurance that the content of the review will be taken into account (Cherp, 1996, 13). In practice a system of parallel reviews has evolved, conducted by the federal Environmental Review Board, the territorial Committees on Ecology, and interested non-profits. The relative standing of each environmental review is unclear at this time.

Pollution problems diminished during the 1990s, because industrial and military activities have decreased with the collapse of the manufacturing sector and government services since the collapse of the Soviet Union. Logging and mining effects have increased, because of the proliferation of small private operations that are difficult for under-funded government enforcement agencies to monitor and control. Large, well-financed foreign companies and joint ventures have also entered the Russian Far East natural resource industries. Malaysian and US interests have logging contracts in Khabarovsky territory, several Canadian companies are involved in mining ventures in Magadan, and a consortium of foreign companies are involved in oil and gas exploration and production on the continental shelf northeast of Sakhalin.

The small domestic companies are difficult to police because of their ephemeral nature and sheer numbers. Large, well-capitalized foreign and joint-venture operators are much easier to monitor, and are better-positioned financially to follow environmental regulations. Large ventures pose a different kind of threat because of the extensive scale of their operations, and because they have the financial and technological capacity to build new transportation infrastructure opening previously pristine, remote areas to the small operators and fish and game poachers. The large ventures also bring enough funds into the regions to persuade under-funded local and territorial governments to make exceptions to environmental laws and review processes (Jones, 1999).

Further plans for joint Sino-Russian hydroelectric plants in the Amur basin are on the drawing boards. Russian environmental scientists are strongly opposed to the projects, because of the effects of an altered flow regime on the ecology and economy of the lower Amur River (Voronov, 1997, 18).

5.2.3 British Columbia

5.2.3.1 Pre-1870

Early trapping and colonial settlements were frequently developed at the site of native communities, which were concentrated near major salmon migration routes or spawning grounds (Parsons, 1993, 1). Mining became a major British Columbia industry as early as the 1850s. Mines were developed for coal and salt, as well as for gold. The gold rush began in 1858, ushering in the new Crown Colony of British Columbia to regulate the flow of newcomers. The Hudson's Bay Company trade monopoly with the Indians was revoked at the same time (Lyons, 1969, 74).

Heavy trapping pressure likely eradicated beaver populations, altering stream geomorphology, as it did in the contiguous United States.

5.2.3.2 1870-1896

Railroad construction altered landscapes by blasting routes for rail beds, and through timber harvest for ties and fuel. The first intercontinental railway was completed in 1885, drawing additional settlers to British Columbia and improving access to eastern markets for BC's natural resources.

It was common practice in British Columbia to dynamite river channels to eliminate rapids from the 1890s onwards, for the sake of navigation and "improved" fish passage. The practice eliminated some of the best traditional Indian fishing sites and altered salmon habitat (Newell, 1993, 212).

5.2.3.3 1897-1914

Additional railheads reached British Columbia's cities just prior to WWI, leading to competition for eastbound natural resource cargoes. Dams were built for irrigation and hydroelectric development. Logging and mining continued, moving further upslope as the lower elevation resources were depleted. There was increasing dredging, filling and diking in the lowlands to reclaim potential agricultural lands and to build growing urban areas (see various essays in Harris, 1996).

5.2.3.4 1915-1946

A few salmon runs were in obvious decline because of habitat destruction and the blockage of spawning migrations arising from anthropogenic activity (e.g., dam construction, the railroad construction-induced Hell's Gate slide). By 1932, the Fisheries Act was amended to include forest practices language, emphasizing clearing streams and cleaning up slash (Cone and Ridlington, 1996, 150). The amendments evidently did not include splash damming and log rafting, as log drives occurred as recently as the late 1960s (Meggs, 1991, 247).

5.2.3.5 1947-1975

British Columbia experienced an industrial boom after WWII, spurred by the incipient globalization of trade in the aftermath of the war. Land use and natural resource management was beyond the reach of federal fisheries managers. British Columbia was both the major landowner and the regulator of land use and development in the province. Several hydroelectric dams were built during this period, the most well-publicized project being the Aluminum Co. of Canada's dams on the Nanika and Nechako rivers (Figure 3.14). Post-War demand for timber, pulp and paper soared, particularly in the United States.

The timber industry expanded extensively, shifting from coastal areas into the interior, and from southern drainages to the north. Saw mills, pulp mills and mining operations operating along coastal streams released voluminous and toxic effluent into waterways, diminishing biological productivity and creating thermal pollution. Development in the interior was accompanied by government-funded construction of roads, bridges, and new railroads. In southern British Columbia, demand for urban, industrial and agricultural land grew, resulting in the paving over of some streams, channelization of others, and reductions of in-stream flows. (Newell, 1993, 126; Meggs, 1991, 200).

5.2.3.6 1976-2000

Through the present, the logging and mining industries, agriculture and urbanization continue to be the major threats to salmon habitat in British Columbia (Slaney et al., 1996, 27-29). The federal government amended the Fisheries Act in 1977 to address water quality issues. The new provisions theoretically gave fisheries managers additional clout in contending with industrial operators such as the Aluminum Co. of Canada, but in practice many exceptions were made for large corporations. As recently as the early 1990s, the Department of Fisheries and Oceans chose not to prosecute pulp mills and other industrial plants for exceeding their permitted effluent discharges, harming fish and habitat (Meggs, 1991, 216, 245).

In 1986, the Department of Fisheries and Oceans (DFO) issued a "Policy for the Management of Fish Habitat", whose stated goals were: no "net loss" of salmon habitat, habitat rehabilitation, and habitat creation. Habitat restoration and/or creation were to occur where there were economic or social benefits to be achieved for commercial harvesters or local communities – biodiversity conservation was not an element of the policy (Healey, 1993, 256). In 1997, the Provincial Government implemented legislation to protect stream banks by reducing streamside construction, to an attempt to minimize the effects of urbanization on East Vancouver Island (Anderson and Pero, 1998). Whereas urbanization is the main threat to freshwater salmon habitat on Vancouver Island, industrial logging and mining are the most damaging land uses in the remainder of British Columbia.

The Canadian Environmental Protection Act was amended and strengthened in 1999, hopefully providing additional leverage for prosecution of polluters. Enforcement officers have been granted new powers, and citizens have been given standing to sue Environment Canada if the government fails to meet its obligations under the new law (Environment Canada, 1999).

A moratorium was imposed on the development of new salmon farms in British Columbia's waters in 1994, because of concerns over the spread of disease to wild salmon stocks and locally significant elevated pollution levels. BC fish farming produces about 60% as much salmon as the commercial fisheries on wild and hatchery fish in British Columbia. The moratorium was lifted in 1998, but future applications for fish farm siting will be reviewed very closely with regard to the potential for negative effects on wild salmon runs. The burden of proof resides with the applicants, and the Department of Fisheries and Oceans has a wild fish first policy with regard to salmon farm siting (Anderson and Pero, 1998). A more recent concern is that Atlantic salmon escapees from fish farms may be acclimatizing to British Columbia rivers. In 1999, fry and parr were caught for the first time during routine snorkel monitoring of summer steelhead populations (Anonymous, 1999c).

A new salmon program was adopted in 1998, focusing especially on British Columbia's declining coho salmon runs. The new $400 million (CDN) program included fisheries closures to protect weak wild coho runs, habitat restoration and enhancement, vessel buy-back to reduce harvest capacity, and assistance for fishers and their communities to adjust to the new, precautionary and conservation-based approach (Department of Fisheries and Oceans, 1999b).

5.2.4 Alaska

5.2.4.1 Pre-1870

Russian Alaskan settlers did not venture very far inland, and minimally altered the watersheds of southeast Alaska. It is probable that local stands of timber were harvested for construction materials and fuel.

5.2.4.2 1870-1896

EuroAmerican settlers likely had a strong local effect on timber resources, for the construction of everything from homes and canneries to salmon traps and weirs, as well as for fuel.

5.2.4.3 1897-1914

The first gold strike in Canada's Yukon Territory occurred in 1897 (Figure 3.16), followed by others in Alaska. The expanded contact of Interior Indians (Athapaskans; Figure 3.3) with EuroAmericans led to epidemics and native population decline. There were also localized depletions of game. In the early 1900s, Congress created processes for homesteading and gave the Territory the right to incorporate towns. The Territory had no authority to develop its own laws at the time (Haycox and Mangusso, 1996, xxiii).

With the passage of the 1912 Organic Act, Alaska gained a territorial legislature. However, it could not pass any land laws, nor incur any bonded indebtedness, thus there was no local capacity to promote or direct economic development. The few permanent non-native settlements remained small (Haycox and Mangusso, 1996, xxiv).

The first federal railroad projects began in Alaska Territory in 1914, and were completed in the 1920s. Air travel was also introduced in the 1920s. The new transportation routes led to increased contact with the rest of the country (Haycox and Mangusso, 1996, xxiv).

5.2.4.4 1915-1946

Alaska began to change significantly on the eve of WWII, because of the construction of federal military bases in the Territory. The Aleutian Islands were one of the Pacific theaters of the war in 1942, and the military confrontation brought many people to the region (Haycox and Mangusso, 1996, xxvi).

5.2.4.5 1947-1975

Territorial Governor Gruening saw timber concessions in the Tongass National Forest as a promising means of raising revenues in preparation for statehood. Alaskans and the pulp and paper industry successfully pressured Congress to open the

Tongass for harvest in 1947, despite unresolved Tlingit and Haida land claims (Haycox and Mangusso, 1996, xxvi).

Cold War defense spending increased military infrastructure in Alaska, and boosted Alaska's population significantly, particularly during the Korean War (1950-53). Statehood also increased the Alaska's non-native population, as professionals moved in to take up positions in the state government and economy (Haycox and Mangusso, 1996, xxvi-xxvii).

Oil and gas became the major industry in Alaska in the 1960s, after the discovery of the Prudhoe Bay oilfield. Extensive logging began in Southeast Alaska during the 1960s, and according to Baker et al. (1996), harvest practices at the time were inadequate to protect salmon habitat. Although harvest practices have improved, logging still leads to the greatest spatial extent of landscape alteration in Alaska. Development of major municipal areas also began to alter the landscape (Baker et al., 1996, 15).

5.2.4.6 1976-2000

The Alaska Pipeline System was completed in 1977, and oil revenues finally exceeded those from the salmon fisheries and the government sector. The oil and gas industry brought thousands more people to Alaska, spurring the growth of Anchorage and Fairbanks. The pipeline crossed several river systems, but has not caused any major harm to freshwater systems to date.

On the other hand, tanker transshipment of oil led to a disastrous oil spill in Prince William Sound in 1988, the Exxon Valdez spill. The literature on the long-term post-spill effects on salmonid reproduction is inconclusive, with some arguing that reproductive effects have occurred, and others that there have been no discernible effects (Brannon et al., 1995).

In 1980, the Alaska National Interest Lands Conservation Act (ANILCA) withdrew more than 25% of Alaska's land base (383,000 sq km) for conservation as federal parks, national forests, fish and wildlife refuges and wilderness areas. Over 20,000,000 hectares of Alaska was already in some form of preserved status at that time, including national forests (Haycox and Mangusso, 1996, xxix). Logging is still controversial, particularly in the Tongass National Forest in Southeast Alaska.

5.2.5 American Northwest

5.2.5.1 Pre-1870

Colonization began to affect native peoples and landscapes decades prior to settlement of the west coast of the United States and Alaska, via smallpox epidemics introduced by early Spanish explorers and Russian traders. Subsequent smallpox and measles epidemics, along with syphilis, tuberculosis, ready availability of alcohol and increased mortality because of firearms devastated native peoples all along western North America, as well as in the Russian Far East (Gibson, 1992). The first major smallpox epidemic along the Northwest Coast occurred in 1775 (Taylor, 1996). European and American explorers perceived Pacific Northwest landscapes to be sparsely populated (Harris, 1997b, 30).

Early governments placed high value on salmon resources, but did not have the resources or the will to protect them. For instance, the Oregon Territorial Constitution (1848) prohibited the obstruction of salmon streams (Taylor, 1996, 160). A similar California law prohibited all stream barriers to salmon passage, except for Indian fishing weirs (Lufkin, 1991b, 7). The predominant role of government at the time was to facilitate the smooth running of markets and the accumulation of capital, and higher economic values to be gained through the development of water rights, mineral resources and timber usually won out over any individual salmon stream.

In order to accommodate the growing tide of settlers moving to the Oregon Territory, the US Congress passed the Donation Land Claims Act in 1850. The Act established a process for individual claims of unoccupied federal lands in Oregon Territory. Between 1850 and 1855, the Euro-American population of Oregon Territory had increased by nearly 300 percent (Robbins, 1997, 82-83).

California's gold strikes increased the tide of westward migration. Gold was discovered on California's American River in 1848, one month before the treaty of

Guadalupe-Hidalgo transferred possession of California to the United States. News of the gold strike had not yet reached Mexico City or Washington, D.C. The discovery prompted a rush of settlers that began California's rapid economic development in 1849 (Bean and Rawls, 1988).

5.2.5.2 1870-1896

Mining, logging, grazing, agriculture and railroad construction all had an increasing effect on the landscape during this period as farmers and ranchers followed miners and trappers to the Oregon Country and California. Grazing and intentional channelization of streams for agricultural purposes modified riparian vegetation and soils, with subsequent effects on stream channel morphology because of increases in surface runoff and sedimentation, and decreases in groundwater infiltration, particularly in the more arid East-side drainages within the Columbia River basin (Wissmar et al., 1994, 16).

Hydraulic mining for placer gold brought the Army Corps of Engineers to California by the end of this period. Hydraulic mining reached its peak in California in the late 1860s and 1870s. Extensive levees were built by farmers to protect their lands from channel change because of upstream mining activity. Farmers did not initially protest mining practices, because the markets for their produce depended on mining-related personnel. The levee system redistributed mine tailings further downstream in the Sacramento-San Joaquin River basin, by increasing the velocity and volume of episodic floods, thereby increasing stream power. As a result of farmer-instigated litigation, a permanent injunction was obtained against hydraulic mining in one of the major subbasins, virtually ending the practice in California. Congress authorized the Corps to clear mining debris from California's rivers in the 1890s (Mount, 1995, 206-207; Lufkin, 1991b, 9-10).

The US General Mining Law (1872) promoted mining on public lands as a means of drawing more settlers to the west. The original law, still in force today, contains no provisions for royalties to the federal government, environmental safeguards in mine siting decisions, or requirements regarding reclamation. Hard rock mining for gold, silver, copper, zinc and other minerals has had long-lasting effects on California's rivers. About 1% of over 15,000 abandoned mines are actively discharging fluids. Acid mine drainage is bioaccumulated by salmon and trout in lethal doses in rearing areas near such mine sites. State regarding mine reclamation and federal clean water standards were not enacted until the 1960s and 1970s (Mount, 1995, 211-212; American Fisheries Society Western Division, 1997, 1).

Water quantity and quality declined further because of agricultural, urban and industrial development. An 1870 California law mandated that fish passage be assured at all dams, but it was poorly enforced. Mining-related water diversions persisted after mining ceased in California, converted to irrigation diversions. Direct discharge of effluents from all types of food and natural resource processing operations contributed to water quality declines. Urban sewage was discharged directly into streams and bays. Introductions of non-native fishes such as striped bass, shad and carp also affected salmon stocks (Lufkin, 1991b, 13-14).

5.2.5.3 1897-1914

The US Army Corps of Engineers (ACOE) and the Reclamation Service became major players in western water development beginning at the turn of the century, and subsequently have significantly altered the carrying capacity for salmonids. The US Army Corps of Engineers (ACOE) was created in 1824 to develop and maintain the navigability of US waterways. With the passage of the Rivers and Harbors Act in 1899, the authority of the Corps of Engineers was expanded, and it became responsible for permitting activities that would alter the contours of a navigable waterway through dumping or course alteration. The Corps was initially involved in navigation-related activities major salmon-producing systems such as the Sacramento-San Joaquin system and the Columbia River basin (Mighetto and Ebel, 1994; Lufkin, 1991b, 14).

The Reclamation Service (today's Bureau of Reclamation or BuRec) was established in 1902 to assist western settlers in irrigating and thus "reclaiming" arid lands. The agency's mission was emblematic of conservation politics in the progressive era, promoting efficient use of river resources benefiting the maximum number of people (Mighetto and Ebel, 1994). The Bureau completed its first mainstem Snake River dam in 1909. By that time, smaller Bureau projects in the Columbia Basin and elsewhere in the West had already irrigated 125,000 acres of land (Dietrich, 1995).

In California, a series of five severe floods between 1902-1909 increased support for flood protection dams (Lufkin, 1991b, 14).

5.2.5.4 1915-1946

The Federal Power Commission, later renamed the Federal Energy Regulation Commission, was created in 1920 to license all non-federal hydroelectric dams. By this time, there were already hundreds of private hydroelectric dams on the waterways of western US salmon rivers.

Westerners were frustrated by the narrow navigation emphasis of the Corps of Engineers and irrigation focus of the Bureau of Reclamation. Community leaders were interested in multi-purpose projects that would boost economic development by improving navigation, providing electric power, and irrigating arid lands. Under pressure from Northwest Congressional delegations, Congress authorized the Corps of Engineers to compile systematic basin surveys for multipurpose dam sites on major US rivers beginning in 1927. The Corps' Report regarding the Columbia River was issued in 1931, and recommended the development of ten multi-purpose mainstem Columbia River dams. The first two dams, Bonneville and Grand Coulee, were begun in 1933, as emergency public works projects during the Great Depression. A coalition of interior interests united as the Inland Empire Waterways Association eventually won approval for McNary Dam and four additional dams on the Snake River (Lang, 1996). Similarly, the Central Valley Project in California was funded as a federal emergency relief project in 1935 (Lufkin, 1991b, 15).

The multipurpose dams in the Columbia Basin and the Central Valley Project were approved during Commissioner Bell's tenure as the US Fish Commissioner. Bell, a real estate developer interested in regional development, was very supportive of

Alaskan rights in the battle with outside cannery owners. In the case of the Columbia River, he supported hydropower-led economic development. His staff knew the perils to the salmon runs, but felt that the technological solutions – hatcheries – were well in hand. A 1934 Bureau of Fisheries report concluded that "nearly all of the populations of salmon and steelhead trout in the Columbia Basin were depleted" (quoted in Cone and Ridlington, 1996, 48). The Report salved the conscience of development promoters and worried many salmon biologists. Biologists were not in accord regarding the potential for hatcheries and fish passage to mitigate the effects of the dams.

Increasing concern regarding overgrazing on federal rangelands managed by the US Bureau of Land Management and the US Forest Service in the 1920s prompted Congress to pass the Taylor Grazing Act (1934). The Act led to a range of cooperative programs through the Forest Service, Bureau of Land Management, the US Soil Conservation Service and private landowners to improve grazing and land management practices. Initial improvements were directed at uplands, and little attention was paid to grazing effects on riparian and stream conditions prior to the 1960s-1970s (Wissmar et al., 1994, 16).

WWII may have had a stronger effect on industries competing for river resources than it did directly upon salmon harvests in the contiguous United States. Fisheries biologists argued for smaller, more efficient and less obstructive hydroelectric dams, but this argument did not prevail, because of the electric power demands by the aluminum industry (aircraft for defense) and shipbuilding, and proponents of extending navigability to the wheat producing regions of Idaho. Hanford Atomic Works was sited on the Columbia River, and also brought new residents and demand to the most productive salmon drainage outside of Alaska (Mighetto and Ebel, 1994). The War Production Board spurred new private-public hydroelectric power-sharing arrangements that persist to the present (Blumm and Bodi, 1996c).

5.2.5.5 1947-1975

All told, over twenty major dams were built by the federal government and public utilities in the Columbia River basin between 1947 and 1975 (Joint Columbia River Management Staff, 1994, 4-5). The Korean War and the Cold War between the Soviet Union and the United States assured that hydroelectric generation for the aluminum industry remained a strategic national priority (Lichatowich, 1999). Adult, and then juvenile fish passage was an increasing concern in the Columbia River basin, and in-stream flow was a worrisome issue to a variety of water users faced with California water projects. A coalition of farmers, fishers, duck hunters and the California Department of Fish and Game sued the federal government in 1951, regarding the inadequacy of in-stream flows in the San Joaquin River after the construction of Friant Dam. In *Rank v. Krug*, the state attorney general found that the federal government was exempt from "state interference" with regard to flow management. The ruling was followed a few years later by a Water Rights Board ruling that in-stream flows for salmon were not "in the public interest". The USFWS was unable to weigh in to support the California Department of Fish and Game because of lack of support from its parent agency, the Department of Interior. These two decisions seriously set back efforts to protect salmon stocks in the contiguous United States from water development (Lufkin, 1991b, 18-19).

Splash damming continued as a method for log transport in many streams as late as the 1950s. Regulation of log transport was a matter of state jurisdiction, and Oregon had banned the transport of unrafted logs in navigable rivers in 1919. The remnants of splash damming left many streams obstructed by log jams extending over distances measured in hundreds of meters. The combination of concern over fish passage and the presence of such obstructions prompted an emphasis among academic and agency fisheries biologists on stream clearing. In the 1970s, fisheries biologists became concerned over the practices, as they recognized that complete clearing of streams removed hydraulic complexity, and led to further stream channel simplification and reduced fish habitat (Gregory, 1996).

Congress became increasingly proactive in the environmental arena during the 1960s and 1970s. The first major act that had a substantial effect on salmon conservation was the National Environmental Policy Act (NEPA) of 1969. The Act provided a process for the environmental review of federal projects and activities, to assure that they minimize negative effects upon the environment. The environmental review process opened agency decision making to the public as never before, and gave environmental groups a much stronger tool to battle water development projects. The Act also gave individuals standing to litigate against federal agencies if they violated its procedures. Perhaps the federal agency most affected by NEPA was the US Forest Service (USFS). After its passage, the Forest Service altered its planning process to bring it into compliance with public participation requirements. Given that the USFS owns xx% of the land base in the range of Pacific salmon in the Pacific Northwest, Forest Service land use decisions are critical to the status of salmon populations. NEPA gave fisheries and environmental advocates a strong tool to force the USFS and other federal land owners such as the Bureau of Land Management to comply with federal environmental laws.

In 1970, the Environmental Protection Agency (EPA) was created to carry out Congress' growing environmental agenda. The Clean Water Act (1973) and subsequent amendments require permits for point-source discharges and state agency action to minimize non-point source pollution. Non-point pollution includes thermal pollution as well as organic and inorganic substances. EPA water quality standards have become a strong leverage point for improving salmon habitat in some locales, particularly with regard to thermal pollution.

5.2.5.6 1976-2000

The population of the American Northwest grew rapidly during the early part of this period. Urban sprawl paved over highly productive low-gradient reaches of many stream systems up and down the Pacific coast. Mining activity abated, but timber harvests were just beginning to crest in the late 1970s and early 1980s.

In anticipation of salmon listings under the Endangered Species Act, federal and state land management agencies revised their planning processes to provide a rational process for balancing their resource extraction mandates against the provision of salmonid habitat. A reasoned agency decision process is a key defense for any federal agency against litigation on the basis of neglect of obligations under the ESA (Dahlstrom and Hildreth, 1997). The process devised under by the Forest Ecosystem Management Assessment Team (FEMAT) includes formal watershed analyses prior to the development of any future harvest plans and minimum riparian buffer standards (Forest Ecosystem Management and Assessment Team, 1993). The FEMAT's approach was codified in Forest Service and Bureau of Land Management regulations in 1994 (USDA and USDI, 1994). Oregon, Washington and California all revised their forest practice codes for state and private lands during the same period, relying on a combination of site assessment and riparian buffers to protect salmonid habitat.

The hydroelectric utilities and agricultural water users are also facing pressure to alter their modus operandi. In California alone, there are now over 1,200 non-federal and 180 federal dams in operation (Mount, 1995, 313). Endangered Species Act listings of threatened and endangered salmonids in the Columbia River and Sacramento-San Joaquin basins and many smaller watersheds are forcing water users to alter flow regimes and improve passage for anadromous fish, and to provide funds for habitat restoration and mitigation (e.g., Anonymous, 1999, 1-2).

During the 1980s and 1990s, all of the contiguous states have enacted laws to protect instream flows, particularly for cold-water fishes such as salmon and trout. Each state's system varies in is structure, scope and actual application. Most do not consider instream needs for the larger aquatic ecosystem beyond the minimum essential water quantity and temperature for salmonids present in the system during summer low-flow (National Research Council, 1992, 80-82).

5.3 Endangered Species Law

All jurisdictions but British Columbia, Canada, now have some form of federal endangered species legislation in place. US legislation is the oldest, dating to 1973.

The United States is the only country among the four in this study, which does not use the World Conservation Union (IUCN) Red Book system and rankings of endangerment. Japan. Similarly, Japan, Russia and Canada all refer to the Convention on Biological Diversity (1992, entered into force 1993) in their draft or current endangered species legislation, tieing national to international objectives. The United States is the only non-signatory to the Convention among the four countries.

Nonetheless, United States' endangered species law has more effect on commercial fishing practices and land use than do the laws of any of the other North Pacific salmon countries. Citizens' and conservation organizations' standing to petition for listings and to litigate if the federal government is out of compliance with the US Endangered Species Act assures greater political and economic attention to biodiversity conservation in the United States than elsewhere around the North Pacific (see Chapter 10 for further discussion).

5.3.1 Japan

Japanese endangered species law has not affected the commercial fisheries to date. Japan's Environment Agency compiled its first Red Data Book of Animals, using the International Union for the Conservation of Nature model, in 1991. Biodiversity preservation and endangered species have become a higher profile issue since Japan ratified the Convention on Biological Diversity in 1993. An endemic form of kokanee *O. nerka kawamurae* is extinct, Sakhalin taimen *Hucho perryi* is endangered within its range in Japan, two forms of Dolly Varden *Salvelinus malma* are classified "near threatened", and two forms of white-spotted char *Salvelinus leucomanis* and cherry salmon *O. masu* are listed as locally threatened populations (Biodiversity Center of Japan, 1999b). Policy for addressing endangered species is contained in the Basic Environment Law (1993; Japan Environment Information Center, 1999a). Current policy seems to indicate an emphasis on habitat protection and the creation of a network of preserves, rather than aggressively limiting harmful economic activities (Japan, 1995).

5.3.2 Russia

Russian endangered species law has had little effect on salmon fisheries. Protection of endangered species is described in Article 24 of the Law on the Animal Kingdom (1995). Species are listed in either federal or constituent territory Red Books, on the International Union for the Conservation of Nature (IUCN) model. The only Russian Far Eastern salmonids listed are Kamchatka steelhead (the anadromous form of *Oncorhynchus mykiss*) and Sakhalin taimen (*Hucho perryi*) in the Sakhalin Island portion of its range (1985 and 1997, respectively).[21] Take is now permitted only with a special permit for scientific research, approved by the Committee on Environmental Protection in Moscow and the appropriate regional Rybvod. In theory, these listings have closed down all commercial fisheries with bycatch of the listed species. In practice, there is insufficient information about bycatch rates and locations, and no political will to pursue a full suite of regulations. Poaching pressure on both species continues unabated (Zolotukhin and Semenchenko, 1998; Karpovich, 1999).

5.3.3 British Columbia

Thus far, endangered species designations have not played a role in Canadian salmon management. Under Canadian law, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), composed of governmental, non-governmental and independent experts, makes species status determinations. COSEWIC has operated informally since 1978, but its status was raised in 1998. Species at risk legislation is pending at the federal level and in the provinces, and COSEWIC's status will be formalized in the new law. Once a species is listed as endangered, threatened, vulnerable or indeterminate, conservation efforts are implemented by the interagency Committee on the Recovery of Nationally Endangered

[21]. The classification systems vary in the US and Russia – the Russians refer to *O. mykiss* as *Parasalmo mykiss*, and to *Hucho perryi* as *Parahucho perryi*. Siberian taimen (*Hucho taimen*) is listed as vulnerable in European Russia, the Urals and the Arctic drainages, and Ob River lenok (*Brachymystax lenok*) is listed as endangered (Zolotukhin and Semenchenko, 1998). *Salvelinus alpinus erythrinus*, *Salmo salar morph sebago*, and *Salmo trutta* are all listed as vulnerable at the subspecies level (Shilin, 1997).

Wildlife (RENEW). Environment Canada and the Canadian Wildlife Service are the lead coordinating entities. At present, no Pacific salmon are listed (Environment Canada and Service, 1999).

5.3.4 American Northwest and Alaska

The federal Endangered Species Act (ESA) of 1973 represented another incursion of the federal government into an area that had previously been state jurisdiction. The Act charges the Fish and Wildlife Service (or the National Marine Fisheries Service for anadromous species and marine mammals) to protect threatened and endangered species at the population level in order to prevent extinctions. The law was designed to supercede a patchwork of state fish and game laws and variable levels of enforcement, given that the ranges of flora and fauna crossed state lines, and markets for threatened and endangered species are usually national or international. Subsequent amendments to the Act directed the Fish and Wildlife Service (and the NMFS) to protect habitat and plan for species' recovery.

The first petitions to list salmon under the Endangered Species Act occurred in the late 1970s, and were unsuccessful. The first salmon listings under the Act were the Snake River (Columbia River basin) fall run chinook, the Snake River spring/summer run chinook, and the Snake River sockeye in 1991-1992. (See Chapter 10 for additional discussion). The ESA salmon listings triggered a requirement that all federal agencies whose actions might affect the threatened or endangered population must first consult with the National Marine Fisheries Service. Listings immediately affect harvest strategies, designed by the states and the Pacific Fisheries Management Council. Managers must now practice "weak stock" management, to assure that the weakest wild stock in a mixed fishery is not overharvested by commercial, tribal or recreational harvesters.

Salmon listings have also prompted reviews of state and federal hatchery programs for their effect on listed wild salmon populations. Many state hatcheries have been either mothballed or closed completely in Oregon State, and many of the Columbia River basin hatcheries have been refocused to restore wild populations rather than augmenting salmon runs to provide a larger fishable biomass. In the Columbia River Basin, the ESA required the NMFS to review the adequacy of the hydroelectric operators' flow shaping and the ACOE's policy of barging juvenile salmon downriver to reduce mortality, under the "incidental take" provisions of the Act. The NMFS was initially reluctant to take on the hydroelectric industry, and was forced by Idaho and tribal organizations to reevaluate the Corps of Engineers flow shaping and barging policies. To date, these reviews have not lead to a significant change in status quo river operations (Cone and Ridlington, 1996, 323).

Oregon and Washington fish and wildlife agencies adopted wild fish policies in 1992 and 1997, respectively, on the heels of the first salmon listings under the Endangered Species Act. The policies define best management practices for harvest and hatchery management and for habitat improvement in order to minimize the risk to wild (or natural) salmon populations (Bakke, 1996; Washington Department of Fish And Wildlife, 1998).

There have been no listings to date of Ecologically Significant Units (ESUs) for Pacific salmon or steelhead in Alaska.

CHAPTER 6 PROPERTY RIGHTS

Property rights in fisheries are incomplete rights. According to classic liberal economic theory, property rights usually include the right of exclusion, the right of alienation or sale, and the right to profit from one's possessions. Implicit in the above list is the right to manage property as one sees fit. This conception of property rights arose out of a particular economic and political environment in Europe, in the context where one had no political rights without land ownership, and land ownership was vested in the hands of the Church and an elite minority of the population.

Fisheries have generally been referred to in the management literature as a common property resource – shared property without clear title. In aboriginal societies, this was generally not the case. Fish and other wildlife were not common property belonging to no one, they were communal property belonging to everyone, utilized to support the extended family group, rather than for individual betterment.

Aboriginal fisheries had much in common all around the North Pacific. Salmon was an essential part of the diet of most native peoples in the greater Pacific salmon ecosystem, serving as a critical source of stored protein for the winter in the form of dried fish. As such, salmon was an insurance policy for years when the marine mammals were not abundant for the Chukchi, Aleut and Eskimo, or when the game was not abundant for interior peoples such as the Athabaskans, Udege or the Columbia Plateau peoples. Native peoples employed fishing practices that resulted in conservation. For example, the Ainu harvested salmon for overwinter preservation from among the spawned out fish, thus maintaining high levels of escapement. The spawned out chum kept better, as they were not as fatty. Salmon to be eaten that day were harvested before they had spawned (Kayano, 1998a). The native peoples of the North Pacific have similar mythologies and religious practices involving salmon harvest practices and river veneration (Walker, 1993; Black, 1988; VanStone, 1988).

The basic unit of the political economy was the extended family or kin group. Fishing sites were owned or stewarded by the elder male of a kin group, who controlled access to a greater or lesser degree in different native cultures (Langdon, 1989). Culture revolved around subsistence harvest of salmon and other natural resources, around life-cycle ceremonies (birth, marriage, etc.), and trade. In the North American Pacific Northwest, trade was gift-based, and was likely dominated by kin groups as well. It was customary for high-ranking families in winter village communities to seek out marriage partners from other villages and other language groups, in order to broaden outside ties. These ties built wealth and prestige, by virtue of the communication and gift network they created. New ties also served as a type of insurance – the more salmon fishing sites one had access to by blood or marriage, the more likely one was to harvest enough for the family even in poor run years (Boyd, 1996, 73).

Colonial powers altered native relationships with salmon and among peoples. Salmon harvests were commercialized – produced at one location and consumed at another. Early trade relationships were barter based, but quickly shifted to a cash basis in most regions. In most cases native harvesters were displaced as they were insufficient in number and often culturally not suited to wage labor. Native harvest rights were explicitly recognized in some parts of Canada and the contiguous United States, but not in other jurisdictions. New systems of harvest rights evolved either in parallel to or displacing native harvest rights.

Current fisheries rights can be described as: 1) the right to harvest; 2) the right to profit from harvest; 3) the right to manage and exclude others, and 4) the right to manage essential fish habitat. These rights may all be held either individually or collectively (Marchak et al., 1987, 3-14). The five jurisdictions vary in terms of the allocation of these rights, collective versus individual-based rights, and the stability of fishing rights over time. Table 6.1 summarizes the overall variation across space and time.

Table 6.1 Variation in property rights across jurisdictions in the North Pacific. The final column ranks relative stability in property rights for each constituent group within jurisdictions over time.

	Right to harvest **Fish-Based**	 **Space-based**	**Sell catch**	**Manage access**	**Manage habitat**	**Collective or individual**	**Stability over time**
Japan							
FCAs	--	X	X	X	Limited	Collective	high
Ainu	--	--	--	--	--	--	high
Large companies	X	Early years	X	--	--	Juridical person	low
Anglers	X	--	X	--	--	Individual	medium
Government				Limited	X	Collective	High
Russia							
Former collectives	X	unclear	X	--	--	Juridical person	M
Large companies	X	--	X	--	--	Juridical person	M
Natives	X	unclear	X	unclear	Unclear	Collective	M
Others	X	--	no	--	--	Individual	M
Government	Pre-'92	Pre-'92	Pre-'92	X	X	Collective	M

Table 6.1 (Continued)

	Right to harvest Fish-Based	Space-based	Sell catch	Manage access	Manage habitat	Collective or individual	Stability over time
British Columbia							
Canners	X	Early years	X	--	--	Juridical person	H
Owner ops	X	--	X	--	--		M
Natives	X	X	Limited	Limited	Limited		L
Anglers	X	--	--	--	--		H
Government	--	--	--	X	X	Collective	H
Alaska							
Canners	X	Early years	X	--	--	Juridical person	H
Owner ops	X	--	X	--	--	Individual	M
Natives	X	--	Limited	--	--	Individual	M
Anglers	X	--	--	--	--	Individual	H
Others	X	--	--	--	--	Individual	M
Government	--	--	--	X	X	Collective	M
US-WOCI							
Canners	X	Early years	X	--	--	Juridical person	H
Owner ops	X	--	X	--	--	Individual	M
Natives	X	X	X	Limited	Limited	Collective	M
Anglers	X	--	--	--	--	Individual	H
Government	--	--	--	X	X	Collective	M

6.1 Japan

6.1.1 Pre-1870

Wooden tablets from archaeological excavations in western Japan indicate that as early as the 8th century, salmon was commodified as a tax or tribute item. Customary forms of sea tenure or fisheries rights likely evolved in this period, to assure stable supplies of salmon and other marine resources. A formal feudal structure evolved in Japan during the Edo period (1603-1867 AD). During the feudal period, the land base and adjacent seas of Japan were divided into regional fiefdoms, with the exception of a few mountainous areas. The Hideyoshi government surveyed every fief (han) to assess its taxable agricultural base, and in the process demarcated village boundaries, including sea territories. Some fisheries were reserved for the central government, and others became part of the fiefs of the feudal lords (Ruddle and Akimichi, 1985).

The Hokkaido Ainu depended on salmon, other fish, small game and plant foods for subsistence. Salmon was a focal point of their culture. Communal hunting and fishing territories were clearly defined, based on river basins, and in some communities small surpluses were generated for trade. Salmon was incorporated into the barter trade, which rose and fell with the fortunes of Honshu warlords. The Ainu were on equal footing with the early traders, prior to the creation of the Matsumae domain.

Several decades of warfare between Ainu and Japanese resulted in the ascension of the Matsumae family, the creation of a small feudal domain on southern Hokkaido (Wajinchi), and the Tokugawa bestowal of an Ainu trade monopoly on the Matsumae family in 1604 (Siddle, 1997, 18-19). The Matsumae trade monopoly did not sit well with the Ainu, who were now excluded from mainland ports and required to trade through official channels. The discontent resulted in a 1669 uprising, and a loss of freedom of movement for the Ainu. Matsumae trading posts took direct control over most of Hokkaido. Only a few outlying Ainu were still in a tribute relationship with the Matsumae (Howell, 1995, 29-30; Siddle, 1997, 22). The enlarged trading network reached Karafuto (Sakhalin Island) by 1679, and comprised the first remote, shore-based fishing operations (Siddle, 1997, 20; Hayashi, 1991). Permanent trading posts were established on the island of Kunashiri (one of the Kurile Islands/Northern Territories) by 1782 (Figure 3.4).

The Ainu-Japanese barter relationship, which implicitly recognized Ainu rights to Hokkaido natural resources, eroded in the early 1700s as the Matsumae began to contract out trading posts to mainland merchants and traders in exchange for debt relief. The traders paid the Matsumae a tariff on their trade, and the pressure to produce in combination with the demand for fish fertilizer significantly altered the trade relationship with the Ainu (Siddle, 1997, 20-21). Over the next century, the Ainu became feudal laborers, paid in kind or not at all for their services in the herring and salmon fisheries. Although the Ainu continued to hunt and fish for subsistence during this period, game was increasingly scarce and most had no time to put fish by for their families during the fishing season (Howell, 1995, 45).

In the aftermath of a Tokugawa takeover in the name of national security (1807-1821), the Ainu lost the right to control their own labor when the Matsumae resumed control over Hokkaido. The Ainu population decreased by over 20% between 1807-1854, resulting in forcible resettlement of Ainu and an increase in the use of seasonal Wajin (mainland Japanese) labor. This coincided with the adoption of new fishing gear – seines and gillnets – and increasingly commercialized fisheries financed by Honshu fish traders and suppliers (Siddle, 1997, 21-22; Kaeriyama, 1989, 627) (Howell, 1995, 39). The growth of an independent fishing sector alongside the feudal fishing operations and the decline of the Ainu undermined the need for the Matsumae trade monopoly, and it was rescinded in 1855 (Siddle, 1997, 23).

<u>6.1.2 1870-1896</u>

After the Meiji Restoration (1868), Ainu land was alienated under the Land Regulation Ordinance of 1872. The Hokkaido Colonization Commission promoted immigration and development of the territory. Seasonal Hokkaido residents – the new independent fishers -- had tenure, but no land title. Waterfront land was available tax free through 1877, and fisheries operations could operate without paying a production tax for two years. In 1878, a system was established for private ownership and land taxation. Waterfront land, essential for fishing operations (net-drying and repair, fish processing), was surveyed, demarcated and assessed for taxation purposes (Howell, 1995, 96-98). The new system disrupted communal rights, awarding waterfront property to specific individuals, and there was initially a rebellion among fishermen against the land surveyors. Many of the new parcels were too small to be practical for fishing operations (Howell, 1995, 103-105).

Japanese fishing rights were in a state of flux. The Meiji government nationalized the nation's waters and seafood resources in 1875, discarding customary village rights on Honshu and southern Hokkaido, and feudal operator's rights in formerly Ainu Hokkaido. The goal was to rationalize and modernize the system by instituting a system of rent rights and permits. Uncontrollable conflict and chaos resulted, and the new system was dropped the following year. The traditional system was revived, with de facto fishery ownership now held by the Meiji prefectures instead of the feudal han. The fisheries sector struggled during this period, hurt by government deflation policies in the aftermath of the civil war. New players entered the fisheries at the time, exacerbating conflicts over fishing rights (Ruddle and Akimichi, 1989).

Newly mandated fisheries unions handed control over the fisheries to the largest operators. The Meiji government created mandatory fishing associations in order to minimize disputes and regulate the fisheries. Harvesters were supposed to organize amongst themselves to prevent overfishing, regulate harvest methods, and standardize product inspections. However, the unions were dominated by large pound trap operators (former feudal fishing managers and large independent operators). The trap operators controlled access to the sea area because of coastal land ownership. They established rules that benefited themselves and harmed the independent gillnet fleet (Howell, 1995, 99-100).

The Ainu were hurt most of all. Ainu communities were relocated away from potential agricultural lands, and fish and game were quickly depleted by the newcomers (Siddle, 1997, 23). The Hokkaido Fishing Act was promulgated by the central government in 1876, and within two years the Ainu were forbidden to fish for salmon in all Hokkaido rivers, except the Upper Tokachi. In 1883, the Hokkaido Prefecture forbade Ainu fishing in the Upper Tokachi as well (Kayano, 1998b, 42).

6.1.3 1897-1914

The Meiji regime attempted to actively assimilate the Ainu. The Ainu were now simple wage laborers in the fisheries. Overall, the Ainu role in the fisheries diminished, although there were a few Ainu-owned kelp harvesting operations in northern Hokkaido (Howell, 1995, 96). The Former Aborigines Protection Act was passed in 1899. The law eliminated Ainu standing as an aboriginal people by proclaiming them "former" aborigines. The Act was primarily a social welfare law, designed to modernize the Ainu and integrate them with Japanese society. It granted Ainu small plots of land, to encourage a shift from subsistence to agriculture and eventual assimilation with the Japanese peasantry (Siddle, 1997, 23-24).

The 1901 Meiji Fisheries Law laid the groundwork for differential management of sedentary and mobile resources, and for fisheries varying in capital intensiveness. Four types of rights developed during the Edo period were formalized by the law: 1) exclusive or joint village fishing rights; 2) fixed gear fishing rights for individuals; 3) fixed area fishing rights for the harvest of sedentary resources or fish culture, and 4) special fishery rights to operate large nets in coastal waters and to construct artificial reefs (Kalland, 1990, 192). The new fishing rights were both transferable and leasable. Most rights were initially in the hands of the harvesters but, particularly on Hokkaido, many harvest rights ended up in the hands of outside investors (Howell, 1995, 100).

A licensing system for offshore and distant water fishing operations was created in 1909 (Kalland, 1990, 193). The Meiji Law was amended in 1910 to permit associations to establish and operate fisheries infrastructure facilities and to provide cooperative marketing. It also authorized federations of local fishery associations (Sato, 1992, 76).

6.1.4 1915-1946

Against the backdrop of the Great Depression, the Meiji Fisheries Law was amended twice in the 1930s. The amendments authorized the fishery associations to become true cooperatives by collecting share capital from their members, permitted them to operate subsidiary businesses such as cold storage, and enabled them to provide additional financial services to their members.[22] These amendments increased the control of fishermen over their own catch, by strengthening them vis-à-vis middlemen and fish wholesalers (Ruddle and Akimichi, 1989, 344).

6.1.5 1947-1975

Post-war amendments to the Fisheries Law (1950) closed loopholes that had allowed absentee ownership of fishing rights and the exploitation of rural fishermen as laborers. Residency requirements were introduced, and leasing of fishing rights was prohibited. The new laws replaced some of the older fishing rights with a new system of licenses and community fishery rights, and created a preference an allocation preference for Fishery Cooperative Associations over individuals in some fisheries (Kalland, 1990, 192; Ruddle and Akimichi, 1989, 345-346).

The amendments created three categories of fishing rights, whose regulatory regimes and management arrangements have been tailored and formalized over the past century: 1) free fisheries, with no license requirement; 2) fishing right fisheries, located in the coastal area, composed of set-net operations, aquaculture, and common rights operations, and 3) licensed fisheries. Licensed fisheries are all of the fisheries using mobile gear, operating in coastal, offshore or in distant waters, including any fishery governed by a treaty. Licenses for Association or individual coastal fisheries are controlled at the Prefectural or Inter-Prefectural level, while all distant water and treaty fisheries require national licenses from the Japan Fishing Agency (Yamamoto, 1992).

[22] There were almost 4,000 primary fishery cooperatives in 1933 (Sato, 1992, 77).

Free fisheries include Japanese sport fishing. Japan has a long tradition of individual access to fish resources, given the importance of seafood to the Japanese culture and diet. Saltwater sport fishing for pink, chum and cherry salmon has boomed in the past three decades, as people have increasingly more leisure time and income. Freshwater angling is allowed for cherry salmon only, and is prohibited only during the smolt out-migration. There is some regulation of cherry salmon angling at the prefectural level, but no national regulation. Heavy angling pressure on juvenile cherry salmon has depressed many wild populations, and made fish hatchery operations unprofitable. Freshwater angling for adult cherry salmon is only allowed in certain prefectures on Honshu (Nagata, 1999; Okamoto, 2000).

Fishing right fisheries are granted primarily to Fishery Cooperative Associations, and specify rights to operate fixed gear or aquaculture operations near shore in specified areas. On Hokkaido, FCA harvest areas extend 5,000 m to sea. Common fishing rights to harvest sedentary marine plants and animals are issued only to FCAs, and not to individuals. Licenses for most fishing rights fisheries are valid for 10 years. Salmon caught with beach seines or boat seines from a non-motorized boat fall under this management regime. Together, these fisheries are referred to as the coastal fisheries (Morisawa et al., 1992, 32-35; Nagata, 1999).

Large-scale salmon pound trap fisheries in Hokkaido waters are licensed by the Hokkaido Fisheries Agency. Priority is given to Fishery Cooperative Associations, but many licenses are also held by individuals or corporations, because pound traps are capital intensive and often cannot be supported within a single FCA territory because of spatial and financial requirements (Ruddle and Akimichi, 1989, 347; Nagata, 1999). Salmon gillnet and long-line fisheries are managed jointly by adjacent FCAs, from 5-40 km offshore. This component of Japanese fisheries is composed of small to medium-sized vessels, and licenses are issued by the relevant Prefectures to the Associations for 5-year periods.

National fishing licenses are issued to an individual or a juridical person. If a fishery is treaty-based, licenses are renewed on an annual basis. High seas fisheries licenses are issued for up to a five-year term. Licensing authority rests with the

Prefectural governors and the Ministry of Fisheries, Forestry and Agriculture, but the license process for these fisheries is overseen by the Prefectural Sea Area Regulatory Commission or the Central Fisheries Regulatory Commission. All of the mobile gear fisheries may also be affected by Ministerially set closures, gear, area, and effort restrictions (Ruddle and Akimichi, 1989, 349; Nagata, 1999).

The FCAs own and operate the majority of Honshu hatcheries, as salmon ranching operations. A portion of the hatchery return is realized on the market to support the hatchery financially, part of the run is taken for broodstock, and the remainder is captured in the coastal fisheries. On Hokkaido, FCAs collect salmon broodstock for the Hokkaido National Hatchery on consignment in local rivers (Matsuda, 1992, 164-165).

The Ainu have no special rights to fish for salmon, despite the centrality of salmon to traditional culture. Any Japanese citizen can fish by becoming an FCA member. Membership requires approval by the board of directors of the relevant FCA, and is often predicated upon working for an FCA member in an active fishery for several years prior to application.

Under Japanese Surface Water Management Regulations promulgated in the 1970s it is forbidden for any person, not only the Ainu, to catch salmon swimming upriver to spawn. Any allowance for Ainu people is contingent upon special permits from the Prefectural governor. Permits are limited in duration, and apply only to fish to be used for traditional rituals or academic research (Kayano, 1998b, 44; Nagata, 1999).

6.1.6 1976-2000

The Ainu Protection Act and successor socioeconomic laws had not achieved their objectives by the early 1980s, and Ainu activists were increasingly turning to indigenous groups overseas for information and support regarding native rights (Siddle, 1997). The Former Aboriginal Protection Act was rescinded in 1997, and replaced with the "Law concerning the preservation of Ainu culture and preservation and dissemination of knowledge concerning Ainu traditions", primarily aimed at supporting language and culture. No gains have been made in gaining recognition for Ainu harvest rights (Kayano, 1998b, 26). Ainu today are arguing for riverine fishing rights both to provide access to a traditional food, as a means to revive their culture (Kayano, 1998b, 44).

6.2 Russia

Russia's natural resources have traditionally belonged to the government – first to the tsars, administered by the Ministry of the Government Domain, then to the Soviet government, administered by the Communist Party and a changing cast of executive ministries. Presently, title to most natural resources is retained by the Russian Federation. There is no uniform private land ownership law in Russia, and regulations regarding long-term leases for timber and mineral resources are not uniformly applied across the constituent territories. In general, there appears to be a cultural discomfort with the notion of private ownership of natural resources. In practice, government ownership has meant that a small governing elite has the authority to allocate access to natural resources and reap the profits thereof, given the lack of an institutionalized public role in management of the people's wealth.

Native peoples in the Russian Far East have no treaty rights, but have a similar fiduciary trust relationship with the Russian Federation as do the native peoples of the United States. Native land and resource rights have never been clearly spelled out in legislation or regulations, beyond proclamations of native priority in resource use. The native-Russian government relationship has not changed dramatically between the Tsarist regime, the Soviet era, and the present day.

6.2.1 Pre-1870

The fur rush in Siberia reached the shores of the Sea of Okhotsk by the 1640s, and introduced a tribute relationship to many of the native peoples. The Koryak and Chukchi excluded the Russians from Chukotka and northern Kamchatka well into the 20th century. Native trade relationships, based on gift-giving, were replaced by trading-post relationships supplying alcohol and tobacco in exchange for furs. The

Tungus-Manchu peoples of the Amur replaced their Manchurian tribute masters with Russian masters late in the 19th century, after Russian acquisition of their lands. Despite Tsarist decrees to obtain tribute "with kindness, rather than cruelty", and to let the native peoples manage their own affairs, the traders, Cossacks and military officers on the frontier dealt with matters as they saw fit, often with violence (Slezkine, 1994, 16; Zavalishin, 1999). Kamchatka's native population was estimated to number approximately 20,000 circa 1700. As in North America and on Hokkaido, many of the native peoples succumbed to smallpox epidemics, with two devastating outbreaks recorded in 1768 and 1799 (Vakhrin, 1996c, 6).

As the fur trade declined in the 1800s, the Russians at many of the remote outposts adopted local subsistence lifeways, supplemented by their role as trade intermediaries with outside Russians. When the region was reexplored at the end of the 19th century, many of these "old settlers" identified themselves simply as peasants or foreigners, but not as Russians (Slezkine, 1994, 97-98). Salmon was not a trade item, and harvest rights likely remained unchanged everywhere but the Amur River basin, where Russian settlements were growing.

6.2.2 1870-1896

All natural resources in the Russian empire belonged to the Tsar, and were managed by the Ministry of the Government Domain. Small Russian fisheries supplying local markets did not draw much attention from the Governor Generalship in Irkutsk. The first harvest rights in Russia came about because of Japanese interests in Russian Far Eastern fisheries, rather than pressure from within. The Treaty of St. Petersburg (1875) was implemented by a Russian law, which provided free fishery access to Russian fishermen and charged a poundage fee to Japanese harvesters (Mandrik, 1994, 41).

Japanese shore-based distant-water fisheries increased thereafter, with the growth of the independent fishing ventures in Japan in the early Meiji period. Japanese traders and harvesters appeared in the Amur Sound in the 1890s, interfering with a growing regional fishery and trade network based on salmon resources. Early harvest rights evolved to limit Japanese companies to specific areas and to tax their profits. The first mention of leasing harvest concessions is in 1894. The Primorye Governor Generalship had been in existence at Khabarovsk on the confluence of the Amur and Ussuri rivers for just ten years. The new regional government imposed a law designed to limit Japanese operations on the Amur Sound in order to protect domestic operations. Foreign labor was prohibited in some areas, and new fees were assessed for fish harvest and processing leases. Japanese harvesters were prohibited from fishing in certain bays on Sakhalin (Mandrik, 1994).

6.2.3 1897-1914

By the turn of the century, the Amur River was the primary Russian salmon fishery in the Far East. A series of laws were promulgated, in an attempt to develop clear harvest rights and government compensation for harvest. The "Temporary Law for Production in the Marine Fisheries of Territorial Waters of the Priamurye Governor Generalship" (1901) created a system of lease concessions that was the basis for Russo-Japanese fisheries agreements for decades to come. A 1st class concession was a five-year lease available to Russians, which conferred harvest rights and an obligation to build canneries, refrigeration or other infrastructure. Only a poundage fee was required for a 1st class concession. Second class concessions consisted of three-year river- or shore-side leases for Russian fish salting operations. Third class concessions were one-year harvesting leases, which required the use of Russian harvesting labor but permitted the use of foreign specialists. The specialist exception was a large loophole, and in practice resulted in the use of foreign labor. Fourth class concessions were one-year leases for processing fish purchased from other lease holders, Russian peasants, or native fishermen. Only the fourth class concessions could be held by foreigners as well as Russians (Mandrik, 1994, 47-48).

Mandrik (1994) states that the Russo-Japanese War (1904-5) was fought over access to fisheries. Although this is not confirmed by any other sources, the conclusion of a fisheries convention was one of the requirements of the peace treaty signed at St. Petersburg. The Russo-Japanese Fisheries Convention of 1907 created a harvest rights framework that persisted until 1928 for Russian harvesters, and until 1944 for the Japanese. The system stabilized property rights and increased investment in the Amur fishery, leading to peak historical harvests in the basin during the 1900s.

The Convention created a system of Convention and non-Convention waters. Foreign harvesters could lease concessions only with Convention waters. There were initially 320 coastal Convention concessions and 265 non-Convention concessions. Leases were let at annual auctions based in Vladivostok, for time periods ranging from one to five years as described in the 1901 Fisheries Law. Tariffs were removed from fish exports, and labor nationality restrictions were removed for most areas, with the exception of the Amur River and certain bays on northern Sakhalin Island. One hundred and fifty river concessions were reserved for peasant and native fisheries, and not available at auction. Haul seines were the only permitted gear on peasant and native leases, and local fishermen paid for fishing privileges through a poundage fee rather than a lease fee (Mandrik, 1994, 58, 162).

The booming salmon fishery on the Amur in the aftermath of the Russo-Japanese War had a dark side. Several Nivkh communities from the lower Amur River were forcibly resettled to make way for Russian and Japanese commercial salmon operations (Otaina, 1994).

The Kamchatka Peninsula became the center of Convention waters, with most fishing conducted with Japanese pound traps. Most of the coastal leases were held by Japanese companies, either directly or sublet from Russian fish merchants (Mandrik, 1994, 54).

6.2.4 1915-1946

During the Civil War (1918-22), the Japanese Occupation Army eliminated the ceiling on Convention and increased the number of leases let overall. Lease revenue during the war was collected by Japan, and was the subject of Soviet-Japanese reparations negotiations in the 1920s (Mandrik, 1994, 72).

The 1918 Soviet Constitution claimed ownership to all surface and coastal waters, and all plant and animal resources. Soviet waters were categorized as central government, local or of non-industrial significance. Central government waters included the breadth of the customs zone out to12 nautical miles, and eleven major river basins, including the Anadyr, Bolshaya, Kamchatka, Taui and Amur. Local waters were coastal waters used for regional commerce. Government revenues were generated by concession fees, gear taxes, wholesale and retail sales taxes (Mandrik, 1994, 99-101).

Although the Soviet government annulled the 1907 Russo-Japanese Fishing Convention in 1923, the basic framework was retained. Concessions now included quotas for the lease area and limited Japanese dry salting to 70% of the production from a given concession. The new system also levied a 5% tax to fund artificial propagation, and limited the volume of fishmeal that could be produced. The processing regulations were aimed at the Japanese, who targeted Russian pink salmon and herring fisheries as a source of fish meal for use as fertilizer in their rice paddies. Government-owned enterprises did not have to bid for concessions, instead paying 8% of the processed value in fees. Separate auctions were held for non-Convention waters, after non-Convention concessions were first distributed to government enterprises and cooperatives. Cooperatives were viewed as an intermediate organizational stage for the peasant fisheries, which would eventually be converted to industrial fisheries (Mandrik, 1994, 101-103).

The collectivization process began in 1928, ending the concession system for all Russians and native harvesters. At that time, anyone could harvest salmon for individual use. Harvest rights were henceforth allocated only to government enterprises and collectives. Collectivization created a spatial pattern of quasi-ownership. Each collective and government enterprise has an assigned fishing territory, assigned with unlimited tenure and without fees. The organizations' documentation describes the coordinates of the territory, the resources available for economic use, and the authorized fishing gear (Zolotukhin et al., 1997) 62. These entities did not have the right to transfer ownership of the territory or its resources, nor did they have the right to control harvest levels. Harvesters did not accrue any of the proceeds from their landings, but did receive bonuses if the harvest targets were exceeded. Their sole prerogative was to harvest as much fish as possible, in order to supply a country in the grip of famine.

Marxist development philosophy dictates that progress is unidirectional, and Soviet leaders set about to drag toward the "malye narody" (numerically small peoples) into the future through an active process of Russianization. Native language and autonomous territory policies were abandoned along with their promoters during the Stalinist purges beginning in 1932. Rural native communities were resettled and organized as soviet towns, usually based upon hunting, fishing or agriculture. The new policy had positive and negative aspects. In many rural areas native peoples had their own local governments. However, they could no longer engage in traditional subsistence activities, on their own schedules.

The new polices were easier on some peoples than on others. Native peoples living in areas targeted for industrial development, or rich in natural resources were usually displaced. The Nanai on the Amur River were organized primarily as fishing collectives, thus retaining a critical element of their culture. The Nivkh on Sakhalin Island unsuccessfully resisted resettlement and collectivization policies designed to convert them from fishers into loggers and farmers. Today there are few fishers remaining among the Nivkh, while most Nanai still live and fish along the Amur River (Khodzher, 1998; Sangi, 1998, 151). Russian peasant families were recruited, and political prisoners and criminals exiled to fell timber, harvest fish, and mine gold (Slezkine, 1994, 269-279).

6.2.5 1947-1975

As salmon stocks declined, the government took drastic action. In 1957, salmon harvest was prohibited to all but juridical persons. All harvest on spawning tributaries was prohibited, aside from small native quotas of 50 kg/person/year (Zolotukhin et al., 1997). In the Amur basin, Nanai and Udege would form fishing brigades each fall to harvest full chum to put by for the winter. Direct harvests ceased in the upper Amur tributaries and in other heavily fished basins by the mid-1960s, because of declining salmon runs and interception in downstream government fisheries. Direct native harvests were replaced by 50 kg/person salmon shipments from the government fisheries, cutting off an element of the culture for many native peoples. Although traditional hand-woven fish traps can still be found in Udege villages, for instance, only a handful of elders still know how to use them (Zolotukhin et al., 1997, 65-66).

By the mid-1960s, native fishing and hunting kolkhozy were reorganized as state enterprises or attached to Russian-dominated collective farms. Stalin's labor camp system, Dalstroi, was eliminated and there was a need for more labor at central locations. Many native villages were again resettled en masse, in the name of efficient economic development (Zolotukhin et al., 1997). Native policy in this period was coordinated by "Northern" or Minority Sections in the Council of Ministers and various ministries, but real authority for native policy rested with Communist Party committees at the krai and oblast level (Slezkine, 1994, 339). Local Party bosses were the guarantors of Plan fulfillment in the Soviet system, thus achievement of economic targets took precedence over native policy and ecological considerations.

6.2.6 1976-2000

No major changes in harvest rights occurred until the collapse of the Soviet Union in 1992. The government harvesting sector had already been through some change during the perestroika period, beginning in approximately 1986. Fishing organizations were allowed to directly export part of their catch and keep a portion of the proceeds for reinvestment. All fishing organizations were to keep their own books and wean themselves of government subsidies. By the 1993 season, fishing enterprises were beginning to suffer as many could not operate without state assistance. Most enterprises had no operating capital, and could not afford essential items such as vessel repair, fishing gear and diesel fuel.

The most solvent government enterprises, usually large operations situated in major urban areas, fared relatively well in the privatization process. Controlling interests in these companies is usually held by former members of the Soviet elite, many of whom are still involved in government and politics. They have access to the allocation process, and are well-positioned to obtain private financing. Former collective fishing varies from jurisdiction to jurisdiction within the Russian Far East (Zolotukhin, 1996b).

Article 69 of the Russian Federation's Constitution guarantees "the rights of indigenous small peoples according to the universally recognized principles and norms of international law and international treaties and agreements of the Russian Federation" (as quoted in King, 1998, 813). There are also native rights embedded in sectoral laws, such as Law on the Animal Kingdom (1993) and decrees regarding the Exclusive Economic Zone (1998) and the Continental Shelf (1995). As in the Soviet era, however, paper rights have not consistently translated into reality for any of Russia's native peoples, including native salmon fishers.

In the absence of well-developed rule of law, native peoples have had little recourse to regain control over former lands and natural resources (King, 1998, 815). During an international conference on native peoples held in Moscow in 1993, President Yeltsin issued a proclamation regarding the establishment of Territories of Traditional Natural Resource Use (TTNRUs), but no implementing legislation has yet been passed at the federal level. In 1995, the Federal Duma passed a decree "On the economic and cultural crisis among aboriginal peoples of the North, Siberia, and the Far East of the Russian Federation". The document was essentially a work plan for the development of legislation regarding native issues: laws regarding native rights, TTNRUs, native self-government, etc. None of this legislation has yet been developed, thus the references to native rights and prerogatives in the above sectoral laws have little substantive meaning (Zavalishin, 1999).

Several of the Russian Far East (RFE) constituent territories have designated one or more TTNRUs for native peoples, but in the absence of federal law and effective local implementation, it is unclear whether the designations have any meaning (Turaev, 1999). Federal authorities do not wish to cede control over natural resources and are reluctant to set any precedent which might lead other national minorities to demand additional territorial rights (Zolotukhin et al., 1997). Russia's economic crisis has also been used as an excuse for not developing native rights legislation (Zavalishin, 1999).

operations, situated in remote rural locations, have fared much worse. They have often reverted to their employees, who have no managerial or market skills, no political connections, and no source of financing. Many have gone bankrupt, and others are still in business in an almost feudal mode. Each season, a larger Russian enterprise or a foreign partner advances the firm funds to purchase fuel and fishing gear, and the financier reaps the profits from the harvest. Some enterprises do not earn enough to pay their employees. The exchange is beneficial to both parties because the former collective still has the documented right to a given harvest area, and the rural enterprise can continue to provide a rudimentary income and some services to the local community (Setun, 1996; Zolotukhin, 1996b).

It is generally accepted that former government fishing enterprises have exclusive rights to fishing territories. However, it is unclear whether it is legal to lease such rights, although it is routinely done. The current system is essentially a limited entry system, because new companies must be approved by the territorial Fishing Committee, along with any new vessels or new types of fishing gear. The Territorial Fishing Committees do not control the level of harvest quotas, but they do allocate them across fishing companies within their jurisdiction. Allocations are usually based on historical precedent at this time, there is no formal policy other than the native allocation priority (Setun, 1996). In addition to fishing capacity and quota allocation, harvesters must also be licensed. Licenses are obtained through the federal Fisheries Conservation, Enhancement and Enforcement Agencies, or rybvods. The 1995 EEZ Law describes the licensing process: in order to receive a license, one must prove that one has appropriate financing, harvesting capacity and an allocation. In order to receive an allocation one must have a license. Politics play a very large role in the present process.

Although socioeconomic policy toward native peoples has varied over time, the basic trust relationship, which guarantees priority allocation of salmon resources, has endured the Soviet regime and its collapse. In practice, priority allocation means that there will always be quotas for native harvest. Whether the fish allocated actually benefit natives through direct harvest, consumption, or sales is questionable, and

Most rural native communities were provided heavily subsidized food, fuel, hunting and fishing gear over the years, particularly as their land base for subsistence activities eroded. In the present economic situation, the subsidies arrive in fractional amounts if at all. Most native communities, and indeed most remote rural communities in the Russian Far East, face high levels of unemployment and collapsing town services and infrastructure.

6.3 British Columbia

6.3.1 Pre-1870

Use rights to fishing sites and fishing gear varied spatially depending on local culture, river basin and species mix. In some areas harvest rights were more communal and in others they were strongly linked to clan lineage or kin groups. Harvest timing and gear usage rules varied from place to place also, depending on relations between native villages up and down stream in a given basin (Newell, 1993, 33-39; Langdon, 1989, 306-311).

Native fishing rights in British Columbia, Canada loosely parallel those of native peoples in the United States. As in the United States, the aim was to clarify Great Britain's title to the land to promote settlement and economic development. Hudson's Bay factor James Douglas negotiated the only extant treaties with Canada's native Indians between 1850 and 1854, according to instructions in a 1763 Royal Proclamation. The fourteen Vancouver Island bands which signed the Douglas treaties forfeited their lands, but were accorded rights to "hunt over the unoccupied lands, and to carry on fisheries as formerly." No further treaties were signed as there were insufficient funds for the minimal monetary compensation to accompany them (Newell, 1993, 47-48).

During the colonial era, Indian populations declined rapidly in Canada because of disease, violence, and competition for resources. Some estimate that the native population declined approximately 80% between 1774 and 1874 (Harris, 1997b, 30).

6.3.2 1870-1896

According to the Terms of Union (1871), British Columbia was to convey sufficient land parcels to the government of Canada to be held in trust for the Indians as reserves. The land conveyances began slowly in 1876, after the initial rush to site canneries had occurred. The province allocated very small reserves to coastal tribes, under the philosophy that access to fishing was all that mattered to those peoples. The result was a patchwork of small and critical reserves, rather than large, inclusive areas. The federal government only grudgingly accepted this approach. Reserves diminished in size over time because of further "cut-offs", for instance provincial land sales to cannery operators. Some reserves were created with provisions for off-reserve Indian fisheries in adjacent upriver or coastal areas. Anti-potlatch laws were passed in 1884, further limiting the Indian economy. Overall policy was aimed at encouraging tribal participation in the Euro-Canadian economy, rather than continuing their subsistence lifeways. The small reserves also led to conflicts between tribes over shrinking resources (Newell, 1993, 55-62).

Early federal fisheries and Indian affairs agents were supportive of Indian fishing rights and the rapid conveyance of appropriate reserves. They expected that further treaties would be negotiated to specify harvest and land rights, and did not want to limit Indian fisheries prior to the conclusion of negotiations. Unfortunately for the tribes, no further treaties were signed, their numbers began to diminish and the canners' power increased. The first intercontinental railway (1885) brought more settlers to the area, reducing the canners' dependence on Indian labor and creating a need for more agricultural land (Newell, 1993, 64-65).

A British Columbia-specific regulatory framework was developed in 1888. The new regulations created a new system of harvest rights by creating the Indian food fishery and a limited entry system for the commercial fishery. The regulations specified the Indians' right to fish for food at any time, using drift nets or spears. It also prohibited the barter or sale of any salmon caught in the food fisheries. This was in part a response to a poor sockeye run on the Fraser River in 1886, and a perception that traditional Indian upriver fisheries were reducing run sizes. For many tribes, salmon sales had been their only source of cash or barter income. Nets were not to span more than one-third of a channel's width, and there was to be a weekly closure during each fish run (Parsons, 1993).

Tribes in the Skeena and Fraser river basins were disproportionately affected, as many of the inland tribes lived too far from the coast to participate in the commercial fishery and cannery operations (Copes, 1999). Newell points out that direct competition was minimal, as the upriver Indian fisheries mostly took chum salmon, which was better for drying. Chum salmon was not targeted by cannery operators until after the turn of the century (Newell, 1993, 65).

Increasing concern regarding sockeye stocks prompted federal licensing for all fishers in 1889. Licenses were allocated disproportionately to canners for their directly-owned gillnet fleet. Initial license limitations did not carry with them any time and area restrictions or landings taxes. There were two means for acquiring additional licenses: acquisition of existing canneries and the construction of new ones. Both occurred, and as a result the effort in the Fraser River fishery increased, eliminating the conservation rationale for entry limitation. Despite the generous terms, the canners and fishers were dissatisfied with entry limitations, particularly in the Fraser fisheries, and they were dropped after the 1892 season (McMullan, 1987b, 109). Thence forward, share-harvesters on company boats were issued licenses directly on the basis of cannery requests, and independent licenses were issued as well. The latter were limited to British citizens only, effectively limiting them to Euro-Canadians and Indians and keeping them from Asian fishers (Newell, 1993, 70).

Many Indians felt that they did not need licenses for the commercial fishery, as fishing was their right. One work-around was for Indians to sell their catch to licensed vessels, for resale to the canneries. Indian harvesters from the interior would have had to travel hundreds of kilometers to obtain licenses. The canneries' solution was to purchase licenses in the Indians' names and provide boats and gear, thus essentially controlling salmon harvests and prices (Pinkerton, 1987, 255). Paying the license fee for Indian harvesters usually guaranteed that wives and children would work in the cannery, and they were a much needed labor supply in the northern districts. An Indian priority was written into regulations for the northern fisheries, thus Indian commercial licenses were the vanguard of the next iteration of cannery-attached licenses and license limitation (Newell, 1993, 76).

6.3.3 1897-1914

While the Fraser River sockeye fishery was fully exploited prior to the turn of the century, the salmon fisheries in the northern region were still expanding. The canners operating in the northern region adopted a volunteer limited entry system, limiting the number of boat licenses per cannery and allocating Indian, Japanese and EuroCanadian harvest labor. The system operated intermittently in 1902, 1905 and 1908, and was not fully effective. The canners' goal was to limit the entry of new processors, to control the number of harvesters and to whom they delivered using "attached" licenses.

Federal fishery managers revised salmon regulations on the basis of a two-year review by the Prince Commission (1905-07). In 1908, salmon canneries and mild-curing operations were required to obtain operating licenses. New cannery licenses in the north were restricted, and northern boat licenses were attached to cannery operations. A joint Dominion-British Columbia Boat Rating Commission formalized the northern system in 1910, eliminating all independent fishers from the northern fishery. The new regulations also banned the use of motor boats in the northern fisheries, although the ban was soon restricted to gillnet vessels only (Newell, 1993, 73-74).

As additional settlers moved to the area prior to WWI, pressure mounted for issuance of individual licenses. The limited entry system then shifted to one of limiting the number of boats in a particular district ("boat-rating"), rather than cannery-attached licenses in 1913. Canners still maintained more control over harvests in the north than in the Fraser River fishery (McMullan, 1987b, 109). As a trade-off, federal licenses for the Northern fisheries carried additional requirements. Some canneries were required to exercise conservation, social and administrative responsibilities e.g., hatchery operation, employment of local and Indian residents, provision of community services and the maintenance of harvest records (Healey, 1993, 248).

Indian tribes were increasingly frustrated by harvest limitations and their shrinking land base. By 1906, Indians had become so frustrated with the reserve system and their shrinking lands that the first of several delegations was sent to London to petition the Crown regarding land rights (Cassidy, 1992). Regulations promulgated in 1910 required Indian fishermen to acquire permits for the food fishery, which could specify both fishing location and gear to be used. Enforcement of reserve-delimited fishing areas became more rigorous, as the fishing industry and new settlers argued for elimination of the food fishery (Parsons, 1993, 426; Newell, 1993, 67). In 1910, the Province decided to cease allotting reserves, and a federal commission was established to review the matter. Reserve lands had not yet been conveyed to the federal government, thus the Province could still alter reserve boundaries. No action was taken on commission recommendations for several years (Newell, 1993, 88).

On the eve of WWI, there were approximately 4,000 Japanese fishers working in the salmon fishery, primarily as share-harvesters for the canneries. Japanese and other Asian fishers were never the majority, but there were more Japanese fishers than either white or Indian (Newell, 1993). In 1914, Euro-Canadian and native Indian fishers were increasingly distressed at what they saw as unwanted competition from a group of harvesters unwilling to participate in strikes, labor and price negotiations. The canners were happy with the status quo, and no changes were made in the harvest rights system until the following period (McMullan, 1987b, 111).

6.3.4 1915-1946

WWI exerted pressure upon the salmon fishery because of increased demand for canned salmon. Federal regulators licensed new canneries belonging to existing operators, and increased the number of attached licenses accordingly. Although the Department of Fisheries would have liked to abandon the cannery-based limited entry system during the war, the work of the Evans Commission postponed that measure. The Evans Report (1917) asserted that there was too much capital and labor in the fishery (Healey, 1993, 252; Newell, 1993, 75).

Regulations issued in 1917 addressed only one component of labor in the fishery – the Indian food fishery. Indians henceforth had to obtain licenses to participate in the food fishery, and further restrictions applied. The in-river food fishery was already subject to harvest restrictions near major spawning grounds and hatcheries. Urban and coastal Indian fishers were often denied licenses, on the basis that they had access to other sources of sustenance. The anti-potlatch law was enforced fully, and increasing food fishery restrictions were applied in traditional Fraser River fisheries, particularly after the Hell's Gate slide. When it appeared that there was some recovery in the Fraser sockeye runs in the early 1920s, food fishery restrictions were extended to other basins. The debate became one over whether the federal government had the authority to regulate the Indian fishing right. The Department of Marine and Fisheries saw the Indian food fishery as a privilege, and the food fishery was seriously eroded during this period. The canners even attempted to provide tribes in some areas with canned pilchards or canned smoked salmon in lieu of their food fishing rights. They were unsuccessful (Newell, 1993, 117-119, 120).

In 1919, returning WWI veterans destroyed the drag seines belonging to a Smith Inlet cannery in the northern region out of resentment at being barred from the fishery. Veterans were guaranteed 30% of northern gillnet licenses in 1919. Pressure mounted for the exclusion of Asian fishers. The Duff Commission (1922) recommended that the cannery contract harvest system be dropped, and that the fishery be opened to independent white and Indian harvesters. Pursuant to the Commission's recommendations, a troll license preference was created for British subjects (Euro-Canadians) and Canadian Indians. Regulations in subsequent years further reduced Asian participation in the fisheries, until the Canadian Supreme Court (1928) and Privy Council (1929) ruled such regulations illegal, on the basis that no qualified individual or juridical person could be excluded from the fishery (McMullan, 1987b, 111). The same case also eliminated federal jurisdiction over cannery operations, limiting federal options for harvest controls to the regulation of individual harvesters (Newell, 1993, 102).

Indians had many grievances in the 1920s regarding land, fishing and hunting rights. In 1924, the Province enacted the recommendations of the federal commission regarding reserve boundaries, enlarging the total area, reducing the total land value, and changing fishing and hunting provisions. In 1926, special Parliamentary hearings were held regarding grievances put forth by the Allied Tribes regarding the 1924 "final adjustments" to reserve boundaries. British Columbia refused to participate in the hearings, and the federal government rejected all of the Tribes' grievances. There was a monetary compensation package crafted in lieu of treaty payments, which came to be known as the "BC Special". The hearings also resulted in an amendment to the Indian Act prohibiting anyone from providing financial support or expertise in the pursuit of land issues (Cassidy, 1992). Indian arguments for reserved fisheries with the right to barter and sell fell on deaf ears. One of the principal arguments against dedicated Indian fisheries was the decision in the Somerville Cannery case, denying the Department of Marine and Fisheries the right to discriminate in license allocations. The Allied Tribes dissolved in the absence of funding (Newell, 1993, 113-114).

The federal government began to levy income taxes on Indian commercial fishing income in the 1930s, despite the fact they did not have regular citizenship. This issue provided the motivation for the union of the Pacific Coast Native Fishermen's Association with the Native Brotherhood of BC (1931), a labor union, in the early 1940s. The new organization improved the wages of Indian cannery workers and is the chief bargaining agent for Indian fishers (Newell, 1993, 116).

During the open entry period from 1922 onward, fisheries associations and unions formed along ethnic, regional and gear group lines. The Depression in Canada led to a period of worker and union activism, as it did in the United States. In 1938, a historic strike for higher fish prices was conducted, uniting several ethnic and gear groups for the first time. This was the beginning of the end of canner control over salmon fisheries in British Columbia. Over the next few years, several associations of fishers, tenders and shoreworkers merged to form the United Fishermen and Allied Workers Union (UFAWU) in 1945 (Meggs, 1991, 150-151, 159-160).

6.3.5 1947-1975

The UFAWU became a powerful presence in the British Columbia fisheries. Harvesters and shoreworkers had become very powerful, and the canners were ready to clip their wings. The canners and a competing union had instigated an investigation under the Combines Investigation Act, the Canadian version of the US anti-trust legislation, in 1956. US fisheries unions had been dismantled in 1947 under anti-trust law as a mechanism for small-business collusion to fix prices. A coast-wide strike for higher salmon prices in conjunction with the Native Brotherhood in 1959 shut down the salmon fishery for almost two weeks. The strike had gained momentum from Combines Investigation, when results from the closed-door process concluded that the UFAWU had engaged in illegal price fixing. During the next round of investigations, the Restrictive Trade Practices Commission announced that the process would be open, and previous records made public. Given the clear record of canner price collusion in the transcripts, the companies worked through their Fisheries Association to shut down the investigation altogether. The UFAWU retained their collective bargaining authority (Meggs, 1991, 168-173).

The harvesters had achieved a degree of control over prices and fishery regulations, through their unity during fisheries strikes. They had gained strength relative to the canners, whose revenues now represented a small proportion of Provincial income relative to the logging and mining industries. Harvesters were pressing for limited entry, to reduce the influx of new fishers during peak years in the four-year sockeye abundance cycle. Canners were opposed, as fleet flexibility enabled them to process more fish at lower prices during boom years. Federal fisheries managers were seeking means to simplify the fisheries and increase efficiency, according to new resource economics theory. Although the canners' Fisheries Association did not welcome limited entry, it worked with federal managers to draft limited entry proposals (Meggs, 1991, 185-186).

The fishing industry continued to be critical to Indian economic well-being. A major study commissioned by the Department of Indian Affairs in the 1960s proposed terminating all special rights for Indians, repeal of the Indian Act, elimination of reserves, and termination of the Indian Affairs Department. The theory was that Indian policies were a drag on economic growth and efficiency, holding people in the hinterlands instead of moving them to urban growth centers. Termination was too controversial to be realistic. Nonetheless, the underlying centralization approach was applied by withdrawing government services from remote communities. Indians were encouraged to move to the cities, especially as salmon canners closed down their older, more remote facilities. As late as the 1950s, the fishing industry provided over 45% of the primary employment for British Columbia's Indians, and served as the primary employer for one-third of the bands, particularly in the northern and central coasts (Newell, 1993, 131-132).

Given the centralization and mechanization of the processing and harvesting sectors, Indians were no longer as important to the salmon industry. Centralization of the canneries in cities provided canners with a ready supply of labor. Replacement of flax nets with monofilament eliminated most Indian womens' net-mending jobs. Indian harvesters held few of the total salmon licenses, particularly in the Fraser River fleets. Many of the vessels Indians fished belonged to the canneries, and Indian-owned boats were often the oldest and smallest in the fleet (Newell, 1993, 132). Thus Indian fishers were, as a group, the least efficient harvesters.

Concerns regarding overcapacity in the salmon fishery led to the Davis Plan (1968), named for the Minister of Fisheries at the time. The major objective was economic: to reduce excess harvest capacity and improve product quality, while minimizing hardship and dislocation among fishers. The two goals were not completely compatible, and proved difficult to execute. The new program was introduced over a period of five years. The first phase was the introduction of a multi-tiered license system, designed to winnow out part-time harvesters. The second phase, a vessel buy-back program, was a boon to the canneries. They were able to retire or upgrade their rental fleets, reinvesting in larger, more capitalized vessels in the seine and gillnet fleets. The program was short-lived, as the average price of a licensed vessel escalated, rapidly expending the government buy-back fund. While the program was successful in achieving the goals of license limitation, fleet reduction, and improvement of product quality, it was not successful in reducing harvesting capacity. The program was also unsuccessful in raising sufficient license fees to pay for fishery management (Healey, 1993, 52-54).

The implementation of the Davis Plan to limit the number of salmon harvesters had severe effects on the Indian fleet, despite a series of special Indian assistance programs. The Davis Plan resulted in an initial reduction in Indians in the fishing fleet, particularly gillnetters who had leased cannery boats. The government assistance programs have been most beneficial to the Indian highliners, primarily in the seine fleet (Newell, 1993, 159-162). While the Davis Plan may not have had equitable results for white and Indian fishermen, the government did make special efforts to be inclusive and to protect remote communities. This was the first government fisheries program that had explicitly socioeconomic goals (Healey, 1993, 52-54).
As in the United States, the native Indian movement was revitalized in the 1970s. Indian fishers pressed for aboriginal fishing rights, conducting food fisheries outside of reserve boundaries. The federal government sought to prosecute tribal chief Noll Derriksan in one of the larger "fish-ins", for conducting a food fishery in contravention of the Fisheries Act. The court found against Derriksan, and the ruling in *Regina v. Derriksan* (1975) that Indian fishing rights were subject to regulation was upheld by the Supreme Court (Newell, 1993, 172-173).

Two years earlier, the Canadian Supreme Court issued a mixed ruling in the *Nisga'a* case, leading to further uncertainty and confusion. The Court ruled that aboriginal title had existed in Canada, but was split regarding whether it still existed or had been extinguished during the colonial period. A Federal Office of Native Claims was created shortly thereafter, to negotiate settlements in non-treaty areas such as British Columbia. The Province refused to participate for the first 15 years of negotiations. The Nisga'a became the first tribe to begin formal negotiations in 1976 (Cassidy, 1992).

In addition to the land claims process, Canadian tribes have also used the courts to forestall economic development projects which would seriously harm traditional hunting and fishing rights (Cassidy, 1992, 21-22).

6.3.6 1976-2000

Harvest rights were substantially altered for Canadian Indians (First Nations) during this period, and it is still unclear how the changes will affect Canadian salmon fisheries as a whole. Despite new calls for further reduction of commercial salmon licenses by the Pearse Commission (1982), no new programs were adopted until the 1990s. In the interim, harvest regulations became increasingly complex.
The *Derriksan* ruling led to a series of crack-downs on Indian food fisheries on spawning grounds outside of official reserves, including an undercover anti-poaching operation in 1977 (Newell, 1993, 173). New regulations in 1977 required Indian fishers to hold fishing licenses rather than permits. Within four years, the regulations were amended to require the specification of species and harvest limits for Indian licenses. The new requirements ired the First Nations community yet further (Parsons, 1993, 426).

Indians persisted in fishing at traditional sites and federal raids on Indian food fisheries continued for the next decade, spawning additional federal and native litigation. In the interim, Canada's Constitution Act, Section 35(1) was amended to expressly recognize aboriginal people and rights. The new clause was a critical element in a landmark Supreme Court ruling, *Regina v. Sparrow* (1990), where the Court accepted a Musqueam elder's argument that in using prohibited gear in the food fishery, he was exercising an aboriginal fishing right which had never been extinguished. Regulation of the food fishery under the Fisheries Act was deemed insufficient evidence of extinguishment of aboriginal rights. Permits for the Indian food fishery were interpreted to be a tool for fisheries administration, rather than a definition of rights (Newell, 1993, 174-175).

In 1991, the newly created British Columbia Ministry of Native Affairs joined with the Federal Treaty Negotiation Office and the Nisga'a in a Framework Agreement for the negotiation of land claims. There are 42 First Nations representing over 100 tribes involved in the British Columbia Treaty Commission process, plus another dozen First Nations negotiating land claims in a separate process (British Columbia Ministry of Aboriginal Affairs, 1999). A 1997 Supreme Court ruling in the *Delgamuukw* case clarified the status of aboriginal rights and aboriginal title, and created a process for consultation with tribes regarding aboriginal rights.[23] The new process created some predictability for natural resource industries in British Columbia (British Columbia Ministry of Aboriginal Affairs, 1998).

The Department of Fisheries and Oceans initiated a multi-year Aboriginal Cooperative Fisheries and Habitat Management Program the same year. An Aboriginal Fisheries Strategy was issued the following year, in response to the *Delgamuukw* decision. The policy increases allocations to the Indian food fisheries, and permits sales of Indian salmon harvests. The First Nations agreed to negotiate an overall limit on food fish allocations, giving the DFO the ability to regulate overall salmon harvests. There were implementation problems with the new policy, particularly regarding enforcement of catch limits, but the situation improved after 1994. The DFO is trying to carefully balance salmon license buy-backs to reduce commercial harvest capacity, salmon enhancement and increased in-river allocations to First Nations. The new Strategy also authorized First Nations experimental selective fisheries, with gear long-banned such as fish wheels and weirs (Copes, 1999). Selective fisheries are now being operated by First Nations on many rivers, and have thus far produced a high quality, high value product and been very successful at releasing weak coho and steelhead stocks upstream to spawn (Parfitt, 1999).

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[23] The *Delgamuukw* case also arose out of an Indian protest fishery. Reacting to DFO raids of their fish camps, the Gitksan-Wet'suwet'en filed suit for jurisdiction and ownership over their tribal lands. Their comprehensive lands claim had already been accepted for negotiation, but the Tribal Council expected negotiations to take several years. *Delgamuukw et al. v. The Queen in Right of BC and the Attorney-General of Canada* was initially heard in 1987, and the Supreme Court ruling followed ten years later. The Gitksan-Wet'suwet'en treaty negotiations are still ongoing (Newell, 1993, 174), (Federal Treaty Negotiation Office, 1999, 6).

The Indian sales provisions of the Aboriginal Fisheries Strategy caused a great deal of strife within the fisheries, as non-Indian commercial harvesters saw the Indian fisheries as direct competition. Industry groups united to present their case, and to limit aboriginal fishing rights (Glavin, 1996, 93-94).

As of June 1999, 50 First Nations or combined treaty groups were in various stages of a formal negotiating process with British Columbia and the Federal Government regarding land claims (Federal Treaty Negotiation Office, 1999, 6-7). The Nisga'a Nation has successfully negotiated a treaty, which now awaits ratification by the Nisga'a Nation, British Columbia and Canada. Each treaty will specify First Nations' fishing rights and their role in fisheries management. In the absence of specific treaty rights, aboriginal "food, social and ceremonial" (FSC) fishing takes precedence in Department of Fisheries and Oceans allocation processes, pursuant to Section 35 of the Constitution Act of 1982, which protects aboriginal rights (Federal Treaty Negotiation Office, 1998, 5).

In 1996, the DFO once again undertook an ambitious plan to reduce the size of the commercial fishing fleet, officially referred to as the "Pacific Salmon Revitalization Strategy." Whereas under the Davis Plan harvesters had been allowed to fish multiple gear types (e.g., gillnet-troller combination vessels) and multiple areas, the Mifflin Plan required that fishers choose a single gear and area per license. A fund was created to buy-back licenses on a closed bid basis. In addition to purchasing and retiring licenses, the new Plan permitted "stacking". A fisher could purchase additional licenses for the same gear in different areas, to accumulate opportunities to fish. Once stacked, the licenses could no longer be sold separately. The Plan has been controversial because of the potential for additional concentration of licenses in urban areas, and the lack of limitations on vessel upgrades. A broad array of interests protested the program shortly after it began, including rural representatives, native groups, environmentalists, fishers and academics. A new infusion of license buy-back and community adjustment funds was added to the program in 1998 (Muse, 1999a).

The current regulatory regime has led to the formalization of a dramatic shift in harvest rights from the commercial to the recreational fishing sector. Historically, salmon quotas were allocated across commercial and recreational gear groups in such a way as to maintain traditional proportions of the harvest, using time and area closures. The sports fishery now has priority access to chinook and coho, and there will be no commercial allocation to the troll fishery unless anglers can catch two chinook or four coho per day. The by-catch allocation for the net fisheries also supercedes the targeted troll fishery priority. Sports fisheries will also receive up to 5% of the total allowable catch of sockeye, pink and chum salmon. In cases when the total allowable catch is very low, sports fishers will not be allowed to retain the latter species (Otway, 1999). Within the commercial fleet, troll fishers have received a portion of the pink and sockeye allocation traditionally reserved for gillnetters and seiners, in order to maintain their earnings (Parsons, 1993, 141).

It is less clear how much of an effect the evolving Indian food fishery will have on harvest rights in the marine and freshwater sports and commercial fisheries. The allocation effect will be greatest for stocks that are in decline, as commercial fisheries will be closed prior to tribal fisheries. The dilemmas facing the Skeena River steelhead fisheries may become more common. Facing a short-term increase in escapement, and perhaps in overall abundance, some are calling for a limited consumptive rather than a catch-and-release fishery. However, if the Skeena steelhead sports fishery becomes a harvest fishery, the First Nations then have priority for allocations. Steelhead regulations are likely to become more controversial (Hooton, 1999, 14-15).

6.4 Alaska

6.4.1 Pre-1870

Ownership and management patterns varied among the native tribes, and were likely most developed for the intensive fishers of western Alaska, the Gulf of Alaska and the northwest coast, and less so for the semi-nomadic hunting and fishing peoples. Among the Northwest Coast tribes, prized sockeye fishing sites were usually owned by particular clans while the less-valued chum and pink fishing sites were viewed as more broadly-held communal property. Temporary use could be granted to non-clan members, or rights could be transferred permanently as a gift or through conquest (Langdon, 1989, 306-308).

Russian colonizers did not affect the salmon fisheries much beyond their settlements. They used their own and Aleut wage labor to fish, using stone weirs, drag seines and traps. The Tlingits did not become directly involved in salmon fishing to provision the Russian American Company, except as landlords. The fish runs near Sitka belonged to Tlingit clans, and access was evidently acquired through barter-leases rather than expropriation (Langdon, 1989, 312-314).

6.4.2 1870-1896

Commercial salmon salteries (1867-) and the canneries that followed beginning in 1878 operated on the barter-lease system, implicitly recognizing Tlingit and Haida customary fishing rights. By the 1890s, Alaska cannery operators began to refuse clan rights to fishing sites, and ceased paying annual lease fees. Although the canneries' labor force was composed of Indians during this period, the fishing trustees for the clans had not asserted control over clan member employment, and thus could not withdraw labor as leverage to retain harvest rights (Langdon, 1989, 315-317).
The first sockeye canneries opened on Prince of Wales Island in 1878. Initially, most harvest was conducted using stone weirs or stationary salmon traps controlled by the canneries, employing Indian harvesting and processing labor. Tlingit and Haida clans at various locations attempted to evict cannery operations, but by 1900, backed by federal fisheries agents and US military might, it was clear that the common property principle was predominant. The federal ban on in-river traps and weirs under the Alaska Fisheries Act (1899) weakened aboriginal rights in the eyes of the natives, as they traditionally lapsed with non-use, and virtually eliminated exclusive native rights in the opinion of the canners and government officials (Langdon, 1989, 348-319). The Act authorized the US Fish Commission to enforce fishing regulations, but only above mean low tide (Cooley, 1963).

Through various lobbying associations, the canners pressed Congress for formal property rights at trap sites. Although they were supported by the Bureau of Fisheries, they were unsuccessful in the more populist-oriented Congress (Cooley, 1963). The canners used the legislative and regulatory process to make substantive gains, in the absence of outright property rights. The 1896 Amendments to the Alaska Salmon Fisheries Act set minimum distances between traps, and between traps and mobile gear. Arguably a conservation measure, the regulation afforded cannery operators quasi-property rights at their trap sites. The Amendments also curtailed the span of fish traps in tidewater, banned in-river harvest in rivers less than 500' wide, and authorized the designation of some streams as no-take spawning rivers. These measures disproportionately affected native subsistence salmon harvests (Langdon, 1989; Pennoyer, 1978, 20).

Alaska's first Organic Act (1884) required that Congress settle Alaskan Native land claims. Congress did not act for the better part of a century (Haycox, 1996, 336).

6.4.3 1897-1914

Independent Indian and Euro-American harvesters gained access to the fishery in the 1900s, with the introduction of purse seines fished outside the rivers, in uncontested coastal areas. Seine fishers initially had to rely on cannery steamers to transport them to the new fishing grounds. By 1910, the introduction of gasoline-powered engines freed them from cannery transport, but fishers remained reliant on the canneries for markets and financing (Cooley, 1963; Langdon, 1989).

The canneries also escaped federal regulation through technological innovation, thanks to the introduction of floating salmon traps in 1907. The new traps greatly increased the number of feasible fishing sites, and reduced cannery expenses by reducing the need for independent harvesters. The new traps soon accounted for over 40% of the salmon harvests in Alaska (Cooley, 1963, 30).

6.4.4 1915-1946

The increase in harvest pressure by the Seattle-owned canneries frustrated Alaskans, and trap robbing became a major problem after WWI and through the 1920s. Unlike similar protests by Euro-Canadian veterans in British Columbia, native and Euro-Alaskan salmon rustling did not result in opening the fisheries to individual fishers. By 1920, there was a diverse fleet of federal vessels deputized to patrol cannery traps, including vessels belonging to the Navy, Coast Guard, the Coast and Geodetic Survey, Treasury, Forest Service and the Department of Commerce and Labor. Alaska canners actively lobbied for Congressional legislation granting preferential harvest rights to trap owners (Cooley, 1963, 98-101). In-stream and closed area harvests also increased, as an Alaskan native protest (Langdon, 1989).

President Harding's Salmon Reserve proclamation in 1922 set off a maelstrom of protest and fact-finding. Preferential access was to be given to cannery-lessors, on the basis of annual harvest permits. While enthusiastically embraced by the Alaska canners, Alaskan residents characterized the move as un-American and monopolistic, making "tenant-fishers" out of Alaska fishermen. The crisis was resolved the following year by the passage of the first comprehensive fisheries legislation for Alaska, the White Act (1924) (Cooley, 1963, 104-119).

During the New Deal, Congress enacted the Tlingit-Haida Juridictional Act (1935), authorizing the tribes to sue for compensation for lands taken in the federal creation of the Tongass National Forest. In 1936, Congress extended the Indian Reorganization Act to Alaska natives, creating the opportunity to form village-level self government, apply for reservations, and borrow from a federal fund (Langdon, 1989). These measures were actively supported by Secretary of Interior Harold Ickes, who now had authority over the new Fish and Wildlife Service in addition to the Bureau of Indian Affairs.

The Bureau of Indian Affairs supported native fishing rights and opposed fish traps, clashing with the new FWS. The Solicitor General of the Department of Interior issued opinions that aboriginal occupancy and possesory rights in Alaskan waters and submerged lands were not extinguished, and that the FWS had the authority to limit traps. The FWS refused to consider such "social and economic issues", insisting that its mandate was to focus on biological issues only. The BIA pursued a lending policy to assist native fishermen to purchase more efficient boats and defunct canneries, while the FWS attempted to legislatively strengthen its authority to regulate harvest (Cooley, 1963).

6.4.5 1947-1975

The Tlingit and Haida, through the Alaskan Native Brotherhood and patrons in the Department of Interior, pursued various legislative solutions to their Tongass land claims prior to filing suit. Unfortunately, pro-statehood and economic development forces in combination with the pulp and paper industry and a national shortage of newsprint after WWII led to the passage of the Tongass Timber Act of 1947. Early versions of the Act had granted varying proportions of the Tongass to the Tlingit and Haida, but the compromises were too little for the Indians and far too much for the salmon canners, who feared the loss of their prime cannery and trap sites. The Act established an escrow fund for proceeds from Tongass timber sales, and included a clause that the legislation should not prejudice any future land claims (Haycox, 1996, 348-351).

The US Court of Claims ruled in favor of the Tlingit and Haida in 1959, the year of Alaska's statehood. Six years later, they were awarded $7.5 million in damages and compensation for the federal taking of tribal lands and natural resources. The Alaska Statehood Act, harking back to the 1884 Alaska Organic Act, required Alaska to relinquish all claims to Native lands and fishing rights. Alaska began to regulate native use of fish and other subsistence resources, despite the Alaska Organic Act's stipulation regarding native claims. Native dissatisfaction with the Tongass settlement and state regulation in combination with Alaskan pro-development interests propelled the passage of the Alaska Native Claims Settlement Act (ANCSA, 1971) (Haycox, 1996, 357).

special privileges in Alaska fisheries, because of historical efforts by out-of-state salmon canners to proclaim harvest rights for fish traps (Petterson, 1983, 314-5).

Alaska amended its constitution in 1972 to permit the creation of a limited entry management system for the salmon fisheries. The Limited Entry Act was enacted the following year. The Act had three objectives: 1) to increase Alaskan earnings in the fishery; 2) to control harvest effort in order to manage on a more sound biological basis, and 3) to assure Alaska residents the opportunity to participate in local fisheries. The goal was to create a system to assist the resident fishing industry, without provoking constitutional challenges. The system was successful in reducing effort and increasing profitability in the salmon fisheries. However, it was not very successful in protecting rural Alaskans' earning potential, particularly native Alaskans. Few native Alaskans successfully completed the initial permit application process (Petterson, 1983, 317-9), and many subsequently sold their fishing licenses outside the community as the permits were freely transferable (Langdon, 1989, 326-8).

6.4.6 1976-2000

Alaska and the federal government continue to differ regarding the legality of Alaska's subsistence policies and native fishing rights. The Alaska Supreme Court ruled in 1989 that Alaska's ANILCA-mandated rural subsistence priority violated the State Constitution's "common use" clause, which left Alaska out of compliance with ANILCA. Fisheries management remained in Alaskan jurisdiction because of a pending native lawsuit, but plant and game management reverted to federal government jurisdiction in 1990. The Ninth Circuit Court of Appeals ruled in favor of native subsistence fishing rights in 1994 (*Katie Johns vs. US and Alaska*), and the Supreme Court declined Alaska's petition for review. Since that time, the Alaska Congressional delegation has blocked federal takeover of subsistence fisheries management by withholding all appropriations for implementation of ANILCA Title VIII (Native American Rights Fund, 1999).

The current status of native subsistence rights in Alaska is unclear. The FWS (the trustee for native fishing and hunting rights) and the Alaska Department of Fish

ANCSA provided cash compensation and fee-simple land transfers to Alaska natives organized into native borough-based or village-based corporations, in exchange for limited land rights and extinguishment of native fishing and hunting rights. The accompanying congressional Conference Committee Report established Congressional intent that the Department of Interior and Alaska take all necessary measures to protect subsistence needs. However, the "common use" clause of the Alaska Constitution mandates that there be no preferential treatment. The Alaska Department of Fish and Game argues that it is discriminatory to grant subsistence preferences only to natives and not other Alaskans, or only to rural and not to urban residents who also rely on subsistence food sources (Native American Rights Fund, 1999).

The US Congress stepped in again in 1980, with the Alaska National Interest Lands Conservation Act (ANILCA) designating national parks, refuges, forests and other conservation units. Title VIII specifically mandates that "rural subsistence use" receive priority over other uses on federal lands. Alaska was delegated responsibility to manage fish and game on federal lands, if it adopted a statute regarding native subsistence priority on federal *and state* lands. If Alaska did not comply, the Department of Interior was authorized to assume control over subsistence fish and game management (Native American Rights Fund, 1999).[24]

Non-residents entered the Alaska fisheries in high numbers by the 1960s, and Alaskans took advantage of their new statehood to try to address the issue. Alaska's first attempt to limit access through regulatory measures in 1962 was based on a desire to cap the number of out-of-state harvesters in Alaska waters. The system was immediately invalidated in federal district court, as a violation of the Commerce clause of the US Constitution. A legislatively designed limited entry system in 1968 also faced judicial challenges and, although it passed muster in the U.S. Supreme Court, it was invalidated by the Alaskan Supreme Court in 1971 as contrary to the Alaskan Constitution. Section 15 of the State Constitution prohibited the exclusive right or any

[24] A federal takeover of subsistence fisheries occurred in October, 1999.

and Game are under court order to come to an agreement by October 1, 1999, or the FWS will again take management control of Alaska's subsistence fisheries (Native American Rights Fund, 1999).

Rising global salmon production and falling market prices are putting pressure on Alaska's salmon industry, particularly for individual fishers. A series of Salmon Strategy Forums in 1997-1998 were held to identify policy solutions. Harvest reduction was identified as a likely solution, and the Alaska's Commercial Fisheries Entry Commission was asked to prepare a review of alternatives for further limiting access to Alaska's salmon fisheries ("fleet reduction and consolidation"). Options are limited by Alaska's Constitution, which limits the degree of exclusivity in any given fishery. Theoretically, the Alaska Legislature has the authority to revoke limited entry permits without compensation, or the Board of Fisheries may completely eliminate specific fisheries. Any action taken to reduce access to Alaska's fisheries is bound to be highly politicized, and does not appear to be imminent (Alaska Commercial Fisheries Entry Commission, 1998).

6.5 American Northwest

In the US Pacific Northwest, there are two types of native rights. The first proceeds from the federal trust relationship of the United States to American Indian tribes. The second is referred to as "co-tenancy", and is based upon original treaties.

6.5.1 Pre-1870

Territorial Governors Stevens and Superintendent of Indian Affairs Palmer signed a series of 9 treaties with Indian tribes or tribal confederations during 1854-55, in order to acquire federal title to territorial lands. The treaties guaranteed the signatory tribes access to their usual and accustomed fishing sites, and a fair share of fisheries resources. Many smaller tribes were omitted from the negotiations (Cone and Ridlington, 1996, 176-180). Eighteen treaties were negotiated by Governor McKee in California by 1851, but Congress refused to ratify them because of pressure from the newly elected California congressional delegation. Indian reservations were established by Executive Order in 1855, but many tribes in coastal areas or prime gold mining areas were decimated by the 1870s. Interior tribes initially fared better, but saw their reservations whittled down to a fraction of their original acreage in most cases (McEvoy, 1986, 45).

6.5.2 1870-1896

Canneries were the cornerstone of the early industry, controlling salmon processing, wholesale marketing, and a large proportion of the harvesting. It was in canners' best interest to control as much harvest capacity as possible, in order to minimize costs. By the turn of the century, quasi-property rights had emerged in some of the salmon fisheries of the contiguous states. In Puget Sound, canneries owned pound traps, which efficiently caught large volumes of fish employing little labor. In the Columbia River basin, two means of controlling harvest emerged – operation of fish wheels and haul seines. Traps in the Columbia River system were independently owned.

Legislation was passed in all of the states (Washington, Oregon, Idaho and California) during this period restricting in-river fishing gear and locations. Although arguably conservation measures, they had the effect of limiting or illegalizing traditional Indian subsistence harvests.

6.5.3 1897-1914

The federal courts began to shape Indian fishing rights in 1905, with a reaffirmation of Indian rights to fish at all "usual and accustomed places" in *US v. Winans*. The case arose as fish-wheel operating newcomers tried to exclude Indians from fishing at sites along Celilo Falls on the Columbia River. The decision was mixed from the standpoint of Indian fishing rights. While it asserted that Indians had a right to fish at all accustomed sites, it also asserted that states could regulate Indian fishing rights, an assertion that would be contested in future legal battles (Cone and Ridlington, 1996, 181).

6.5.4 1915-1946

The reserved right to fish at usual and accustomed places on both ceded and non-ceded lands (reservations) was clarified in subsequent rulings (*Seufert Brothers v. United States*, 1919 and *Tulee v. Washington*, 1942). However, fish runs were already declining in many areas, and dam projects began to flood out historical fishing sites. Indian participation rates in mainstream commercial fisheries were not high. By-and-large, tribal fisheries were conducted in parallel to non-tribal fisheries, using a combination of traditional and new gear. On the Columbia River, for instance, tribal harvests were conducted primarily at Celilo Falls, the site of one of the richest pre-European fisheries in the contiguous United States, using traditional techniques.

6.5.5 1947-1975

Celilo Falls was inundated when The Dalles Dam began operations in 1958. The event marked the end of the last, large traditional fishery on the Columbia River, and the end of commercial fishing above the Bonneville Dam. The Columbia River tribal commercial fishery had persisted as a dipnet fishery long after tribal fisheries in other areas had converted to mobile gear, because of the uniqueness of Celilo Falls. Demands from upstream sports fisheries and lower river commercial fisheries for more fish increasingly squeezed both the newly created Indian gillnet fishery and escapement. Indian fishers became increasingly militant over treaty fishing rights in the following decade, using protest fisheries as a means of attracting publicity to their cause (Cone and Ridlington, 1996, 207-210).

Treaty tribes were increasingly frustrated by the late 1960s, as their salmon harvest dwindled in the face of poor runs and large commercial harvests. In the Puget Sound, treaty tribes are estimated to have taken no more than 5% of the annual salmon harvest per year through the 1970s (Knutson, 1989, 266). The situation in the Columbia River was similar. After the inundation of the Celilo Falls fishery by The Dalles dam, the tribal commercial fishery was moved below Bonneville Dam, and the Indian fishery remained above it. The fishery converted to set gillnet gear. The treaty tribes were the last fishery along the Columbia and, as in the Puget Sound, the conservation burden fell upon them. The situation for the Columbia tribes worsened in 1968, when the John Day and McNary dams were completed and additional dipnetting sites were submerged.

There was an upsurge in litigation relating to Indian fishing rights during this period. On the basis of *US v. Winans* (1905), the states believed that they still had the authority to regulate the Indian fishing right. Beginning in 1963, a series of cases affirmed tribal rights to take fish unimpeded, unless regulation was essential for conservation. *Antoine v. Washington* (1975) provided a test for clarifying the need for a tribal share in harvest reduction to achieve conservation. *US v. Oregon* (1983) clarified that the "conservation necessity principle" applied to fishing at off-reservation usual and accustomed places as well as on reservation. More recently, the principle has been found applicable to federal regulation of tribal fishing and hunting rights (*Makah v. Brown*, 1993).

The court decisions that irrevocably altered salmon management in the Pacific Northwest were those that affirmed the treaty tribes' right to a fair share of the fish. The first decision was in *Sohappy v. Smith* (1969), on the basis of the Columbia River fishery. The ruling stated that the obligation to provide a fair share of the salmon to the treaty tribes was of equal weight to the conservation objective. Judge Boldt of the Ninth Circuit Court subsequently ruled, in *US v. Washington* (1974), that a fair share meant a 50-50 division of the harvestable fish in a run, including hatchery fish. The Supreme Court subsequently endorsed the 50-50 principle in *Washington v. Passenger Fishing Vessel Association* in 1979 (Heffernan, 1998).

These rulings had several consequences for fisheries in Washington and Oregon, and for the treaty tribes themselves. The treaty rights were ruled to be a class right accruing to the tribe, not an individual right. The tribes were to be responsible for allocating the 50% harvest share among tribes and tribal members. Parallel intertribal organizations were formed in the 1970s to coordinate the allocation process and provide fisheries expertise to the tribes – the Northwest Indian Fisheries Commission (Puget Sound and Northwest Washington coastal tribes) and the Columbia River Inter-Tribal Fisheries Commission. The Boldt decision and subsequent cases helped to revitalize the tribes culturally and economically. It also gave the tribes a strategic seat at the table in all decisions regarding salmon allocation and conservation (Blumm and Bodi, 1996b).

The Boldt decision created two classes of fishers – treaty and non-treaty. The states were not eager to enforce the ruling while it was being contested, and non-treaty fishers conducted many protest fisheries. Relations were particularly strained in the Puget Sound fisheries, left with far too many gill-netters and seiners chasing too few fish despite the fact that Washington State had enacted license limitation in 1974. Judge Boldt's court took direct control of the fishery in 1977, further angering the non-treaty fishers. Washington State had banned fish traps as monopolistic in 1934, and the predominant philosophy was one of common property equal access. The non-treaty fishery in Puget Sound was restricted to multifilament nylon gill nets, which meant they had to fish at night. The treaty fishers, on the other hand, could use monofilament nets and fish any time of day. Thus the non-treaty fishers had to contend with Puget Sound recreational and commercial vessel traffic as well as crowded fishing grounds in the dark. The non-treaty fishers felt that they were being discriminated against, and that another group was receiving privileged rights (Knutson, 1989).[25]

6.5.6 1976-2000

Under pressure from the Pacific Fisheries Management Council and the National Marine Fisheries Service to control excess harvest capacity in the ocean salmon fisheries, the states adopted limited entry programs in the 1970s and 1980s. The programs adopted affected state-administered fisheries as well as ocean salmon fisheries, to prevent spillover of effort from one to the other. The introduction of a license limitation and vessel buy-back system in Washington State in 1975 led to the discontinuation of approximately 2,150 permits by 1985, through a series of license

[25] In the Puget Sound fishery, the Boldt decision initially created two classes of fishers among the tribes. Tribal salmon fisheries in the Puget Sound are confined to usual and accustomed areas. The tribes at the head of Puget Sound, in particular the Lummi, Swinomish and Tulalip, invested in purse seine gear and heavily harvested the 50% tribal share. Little was left for South Sound tribes such as the Puyallup.

and vessel buy-back programs funded by the federal government (Natural Resources Consultants, 1986; Muse, 1999b, 4). California limited entry to its salmon gillnet and troll fisheries in the 1970s as well. Oregon imposed license limitation upon the salmon gill net and troll fleets in 1980, supported by a federal license buy-back program.

Judge Boldt did not live to rule on the second phase of US v. Washington, as he had structured the case. In Phase II of *United States v. Washington*, Judge Orrick ruled that the original treaties entitle the tribes to a right to protect habitat necessary to sustain salmon fisheries. However, this decision was vacated by the Supreme Court on the technicality that it was a declaration of right without a specific controversy at hand. A number of lower court decisions have asserted such a right in specific cases, such as *Confederated Tribes of the Umatilla Reservation v. Alexander* (1977). In this case, the Umatillas were able to block the construction of a dam in the Grande Ronde Basin, as it would have nullified treaty rights by inundating usual and accustomed fishing sites and obstructing salmon passage (Heffernan, 1998; Blumm and Bodi, 1996a).

The Hoh, Quileute and Quinalt tribes challenged the Pacific Fishery Management Council's approach to chinook and coho management under the Salmon Plan in the late 1970s, because the Council grouped coho and chinook stocks for the purposes of managing the ocean fisheries. The Council provided the treaty tribes' 50% share in the aggregate, rather than on a fun-by-run basis. This approach allowed for larger ocean fisheries, but differentially affected the weaker salmon runs, sometimes precluding Indian fishing on reservation rivers. The 1981 *Hoh v. Baldrige* ruling stopped this practice, requiring management to take weak stocks into account. The decision greatly complicated annual harvest decision making, and gave the treaty tribes additional influence over management of the ocean fisheries (Rutter, 1997).

Washington State further reduced access to its salmon fisheries in two rounds of permit buy-backs held in the mid-1990s. Endangered Species Act listings forced harvest reductions for coho and chinook stocks in the early 1990s, and the overcapitalized fleets were struggling economically. In contrast to other programs, the federally-financed Washington buy-back program purchased harvest licenses from marine charter boat operators as well as commercial gillnetters and trollers. In 1998, Washington used disaster relief funds after major floods to buy back further permits, this time including Puget Sound seine, gillnet and reef net fishers as well as the previous fishery-gear groups. In addition to the buy-back process, fleet size has been diminished by lapses in individual license renewal because of low market prices for salmon. Nonetheless, it is expected that the actual reduction in harvest capacity is low for most of the fisheries and the remaining harvesters will quickly increase their capacity if market and salmon abundance conditions improve (Muse, 1999b).

CHAPTER 7 CHANGING TECHNOLOGY

Technological changes can be sorted by type – gear innovations and improvements, processing innovations, improved transportation systems, and improved biotechnology for artificial reproduction. New technology sparked a variety of changes in the salmon fisheries in all jurisdictions, and are a recurring theme in Chapters 3-6, 8-10. Table 7.1 summarizes the types of technological innovations that predominated during different periods, across the North Pacific.

Reviewing Table 7.1, it is apparent that all of the extant gear types were in use by WWI. Innovations in transportation and salmon processing globalized salmon markets just as WWI generated an intense demand for canned salmon, spurring the salmon fisheries in all of the jurisdictions to levels considered "full exploitation". All species available and most sizeable salmon runs were fished by the war's conclusion in 1918. Continued improvements in refrigeration and freezing technology reduced the relative importance of canning by the 1960s, and opened new markets for fresh and frozen fish.

Gear and vessel modifications continued to improve harvest capacity, everywhere but in Russia. Vessel improvements also improved the mobility, storage and transport capacity of fishing vessels. The combination of increased mobility and harvest efficiency complicated salmon management. Escapement-based regulation practiced in British Columbia and Alaska has become much more difficult, because of the rapid rate of harvest possible on any given salmon run. For example, in British Columbia, the proportion of trollers and troll-gillnet combination vessels in the salmon fleet more than doubled in the 1970-1980s. The troll fleet fishes up to 50 km offshore, thus harvesting a greater mixture of stocks than the gillnet or purse seine fleets. Very large proportions of weak salmon stocks can be harvested in a mixed stock fishery even in a single day's harvest.

Table 7.1. Technological innovations in the salmon fisheries of the North Pacific.

Period	**Innovation**	**Jurisdictions**
Pre-1870	New and modified gear: pound traps, gillnets	Japan
1870-1896	New and modified gear: purse seines	British Columbia, Alaska, Contiguous US
	Processing: cold storage facilities	All but Russia
	Transportation: trains	British Columbia, Contiguous US, Japan
1897-1914	New and modified gear: floating net traps, troll gear, internal combustion motors for all vessel-based gear	All
	Processing: butchering machines, artificial ice, sanitary cans, crimping machines, double-seamed cans	
	Transportation: trains	Russia's Chinese Eastern Railway
1915-1946	Transportation: heavy duty marine engines, diesel engines, LORAN navigation, fish pumps, radio communications	All
	Gear modifications: power gillnet drums	All but Russia
	Processing: brine refrigeration, processing line improvements, quick-freeze technologies	All, but less likely in Russia until after WWII

Table 7.1 (Continued)

Period	**Innovation**	**Jurisdictions**
1947-1975	Gear modifications: sonar fish finders, nylon gillnets (multi- and later monofilament), seiner power blocks and drums, troll-gillnet combination vessels	Seiners, combination vessels in Western Pacific, other innovations everywhere
	Processing: filleting and freezing technology improvements	All
	Transportation: more seaworthy fishing and tendering vessels	All
	Biotechnology: dry fish feeds, antibiotics, water quality controls	Japan and Contiguous US, followed by British Columbia, Alaska
1976-1998	Transportation/navigation: Global Positioning Systems (GPS)	All
	Biotechnology: genetic analysis techniques, hatchery broodstock protocols	All

One of the most intriguing questions when comparing gear types on either side of the North Pacific is the low level of development of mobile gear, particularly in Russia. The predominant species mix, composed of the schooling species sockeye, chum and pink, are a partial explanation. It was simply not necessary to employ troll gear, which excel at harvesting feeding coho and chinook. It is less clear why purse seines did not become widespread in the Russian and Japanese fishing industries.

Seines appear to have been unnecessary in Russia and Japan given the widespread use of pound traps and the distribution of harvest rights. In British Columbia, Alaska and in the Puget Sound fisheries (American Northwest) because it allowed individual owner-operated vessels to compete with canners for a portion of the harvest. Traps were banned by the federal fishery managers in British Columbia in 1894, in favor of mobile gear. Traps were banned in Washington and Oregon in the 1930s, as part of a populist move to reduce corporate canners' control over the salmon fishery. Alaskans were not able to ban pound traps until statehood, in 1959. Purse seines and gillnets permitted individual owner-operated vessels in Alaska and the contiguous US to compete with corporate harvesters. In British Columbia, the mobile gear was the only gear available to fish for schooling species, and canners developed attached licensing systems and large share-operated fleets in order to retain some control over raw material inputs.

Corporate harvesters also clashed head-on with individual harvesters in Japan. Corporate harvesters owned the majority of the pound traps until WWII, although they were operated by Fishery Cooperative Associations. FCA members also fished gillnet gear. When absentee participation was forbidden by post-WWII amendments to the Meiji Fisheries Law, the federal and prefectural governments adopted a policy of preferential FCA licensing, and encouraged corporate harvesters to focus on distant-water operations. The spatial segregation of large-scale corporate and small- to medium-scale FCA member operations eliminated the need for alternate gear types as a means of competition.

Prior to the Russian Revolution, corporate harvesters also had a monopoly on pound traps in Russia. Peasant and native harvesters engaged primarily in beach seining or set gillnet operations, and had no access to capital or purse seine technology. Collectivization in the late 1920s eliminated any emerging competition, by sanctioning pound nets and gill nets as the official commercial gear. Innovations were stifled by legal prohibitions on the use of any gear not specifically sanctioned by federal regulations. New gear prohibitions remain on the code books in the Russian Federation today.

High-speed ocean transport in combination with brine-refrigeration technologies developed during and after WWII made it possible to freeze salmon prior to canning, reducing high-grading during the fishing season. It also facilitated the centralized location of canneries closer to major transshipment locations, and the closure of remote facilities. Canneries consolidated into diversified fish packers, operating multi-species, year-round plants.

Hatchery technology has also improved greatly over time. Interbasin egg transfers were initially the norm, either because salmon home-stream theory was discounted (United States) or because of the pressure to meet quotas for egg take and fry releases (all jurisdictions). In Pacific Northwest and Russian streams, there have been occasions when entire wild runs were stripped of their eggs and milt to supply hatchery broodstock (Lichatowich, 1999). These practices ended in the Pacific Northwest by the 1970s, but still occasionally occur in the Russian Far East (Zolotukhin, 1996b).

Hatchery production became much more successful in the 1960s and 1970s due to improvements in antibiotics, the formulation of fish feed, and species-specific protocols for water quality, water flow, feeding, and duration of rearing prior to release. Genetic protocols were developed to reduce the risk of hatchery fish introgression, because of poor egg and milt selection and fertilization practices. The latest round of hatchery improvements seeks to minimize the "hatchery selection effect" by creating hatchery rearing conditions, which mimic natural rearing conditions.

CHAPTER 8 INTERNATIONAL APPORTIONMENT OF HARVEST RIGHTS

This chapter provides an overview of formal international apportionments of harvest rights, codified in bilateral and multilateral treaties. Reaching such agreements is contingent upon the larger context of international relations at any given point in time. The political context of formal treaties is discussed where it is known.

Bilateral and multilateral treaties and conventions can be viewed as international apportionments of salmon harvest rights. There are four distinctly different types of harvest-related treaties: 1) bilateral treaties and conventions that grant foreign harvesters rights within a host country's waters; 2) bilateral conventions that apportion harvest between countries that share stocks, because of migration pathways or river basins with split jurisdictions; 3) multilateral conventions that establish the rules for harvest of salmon from all countries of origin during their high-seas rearing and migration, and 4) multilateral conventions that regulate fishing gear.

Other treaties described here do not directly concern salmon allocation, but determine the scope of each country's jurisdiction in the North Pacific. These are boundary treaties, peace treaties, and national laws extending coastal jurisdiction. Although the United Nations Law of the Sea Convention just recently entered into force, provisions relating to anadromous salmon and marine living resource jurisdiction within exclusive economic zones have become accepted as customary international law, even by parties who have not yet ratified the Convention (e.g., United States and Canada).

I will describe the principal international agreements affecting Pacific salmon in the North Pacific in each of my six time periods, but will not break the narrative down by country. Where information is available, I will describe the effects of the agreements upon each country's salmon fishery. As in the previous two sections, I will begin each section with Japan, and work clockwise around the North Pacific to the American Northwest.

8.1 Pre-1870

Agreements prior to 1870 were shaped by the North Pacific fur trade and related colonization. The first North Pacific treaty was provoked by Tsar Alexander in 1821, with a decree attempting to ban all foreign ships from Russian America north of 51° N. The Russian attempt to exclude American and British vessels from the northern fur trade was unsuccessful. It resulted in the *Russian-American Convention of 1824*, guaranteeing that the North Pacific be open to citizens of both nations for fishing, trading and navigation. Yankee traders quickly expanded their range to include fishing, whaling and trading in the Sea of Okhotsk and the western Bering Sea, in fisheries that lasted through the 1870s (Mathisen and Bevan, 1968, 13-14; Stephan, 1994, 39).

Russia and Great Britain signed a parallel treaty the following year, which established terrestrial borders as well as guaranteeing access to the present-day Alaskan panhandle (Gibson, 1992, 62-64). The treaty was unclear about the maritime boundary in Dixon Entrance, and the United States and Canada were still in disagreement regarding this boundary as of 1991 (McDorman, 1991).

8.2 1870-1896

8.2.1 Russia and Japan Adjust Borders

After Russia acquired most of the Amur River basin from China in 1860, the Russian Geographic Society expanded its exploration seaward to encompass Sakhalin Island (Karafuto) and the Kuriles (Northern Territories). Russia was wary of the British establishing an Eastern Front in the Crimean War, and established its first military outpost on Sakhalin Island to reinforce Kamchatka garrisons. By this time, Japan was conducting shore-based fisheries on Sakhalin and along the Russian shores of the Japan Sea without Russian interference. Given mutual concerns over territorial claims, Russia and Japan signed the St. Petersburg Treaty in 1875. The treaty recognized Sakhalin Island as Russian territory and the Kurile Islands were acknowledged to be Japanese. The St. Petersburg Treaty also granted Japan the right to trade and fish along the shores of Sakhalin, liberally interpreted by Japan to include Russian waters throughout the Sea of Okhotsk and along the Kamchatka Peninsula (Mandrik, 1994, 154; Stephan, 1994, 78, 306).

As Japanese salmon harvests began to decline, the government enacted a law that awarded bonuses for fishing and hunting on the high seas, including the Bering, Japan and Okhotsk Seas (Mandrik, 1994, 158). The fishing industry expanded to Russian fishing grounds, first in the nearby Amur River basin (1892) and Japan Sea, and then to the estuaries of the Kamchatka Peninsula (Eniutina, 1974).

8.2.2 Salmon Diplomacy Between the United States and Great Britain

Along the shores of the Eastern Pacific, a transboundary salmon conflict was brewing. The burgeoning Puget Sound fishery, now centered in Bellingham near the Canadian border, was intercepting ever greater volumes of Fraser River sockeye salmon, the centerpiece of the Canadian canning industry. The first formal attempt to address international allocation and fishery management issues was the creation of a US-British Joint Commission in 1892. Canadian fisheries authorities made repeated pleas for agreement on a common conservation strategy, but the United States had no leverage over the Washington State fishing industry (Marchak, 1987, 155).

8.3 1897-1914

8.3.1 The Russo-Japanese War and its Repercussions

Japanese fisheries law was extended in 1902 to authorize distant-water fishing and trading associations in addition to the village-based associations created in the 1901 Meiji Fisheries Law. The Russian government viewed this as government facilitation of Japanese merchant collusion in auctions for Russian fishing leases and restriction of direct Russian fish sales on the Japanese market. The law was protested through diplomatic channels. Mandrik views the increasing tension over fisheries relations as a contributing factor for the Russo-Japanese War, although this could not be corroborated by any other sources (Mandrik, 1994, 160-161).

International relations in the region were very tense at this time. Japan had turned outward since the ascendance of Emperor Meiji, and the European powers were actively carving out trading monopolies and leaseholds on the Asian mainland. China and Korea were particular sources of instability, as they both had foundering governments. Tensions between Russia and Japan over spheres of influence in Manchuria and Korea erupted in 1904 into a full-fledged war (Malozemoff, 1958, 237-249).

Japan declared war against Russia in January of 1904. The war, primarily a naval battle, inflicted significant damage upon fishing operations. Japanese labor was not available for the two years of hostilities, Japanese markets for salmon were foreclosed, and the Volunteer Fleet was out of operation. Tensions were felt as far north as Kamchatka, where Kamchatkan and Japanese fishers waged occasional deadly battles on the salmon grounds during and immediately after the war (Mandrik, 1994, 161; Vakhrin, 1996c, 12).

According to the terms of the Treaty of Portsmouth (1907), Japan regained Sakhalin Island south of the 50th parallel (Karafuto) and a stable fisheries regime in Russian waters (Figure 8.1). The twelve-year Russo-Japanese Fisheries Convention (1907) eliminated Russian export tariffs and created a framework for Japanese leases of Russian fishing grounds in Convention waters. (Thirty-four closed bays and several major rivers, known as "non-Convention" waters, were excluded from the Convention). Japanese harvesting in the Amur Sound and northern Sakhalin were restricted, shifting Japanese distant-water fisheries to the Kamchatka Peninsula. Initially, Japan bought salmon from Russian merchants, but quickly developed relationships with local merchants to sublease fishing concessions (Mandrik, 1994, 157, 162). By 1908, the Japanese fished over 100 leases in Convention waters off Kamchatka (Vakhrin, 1996c,13).

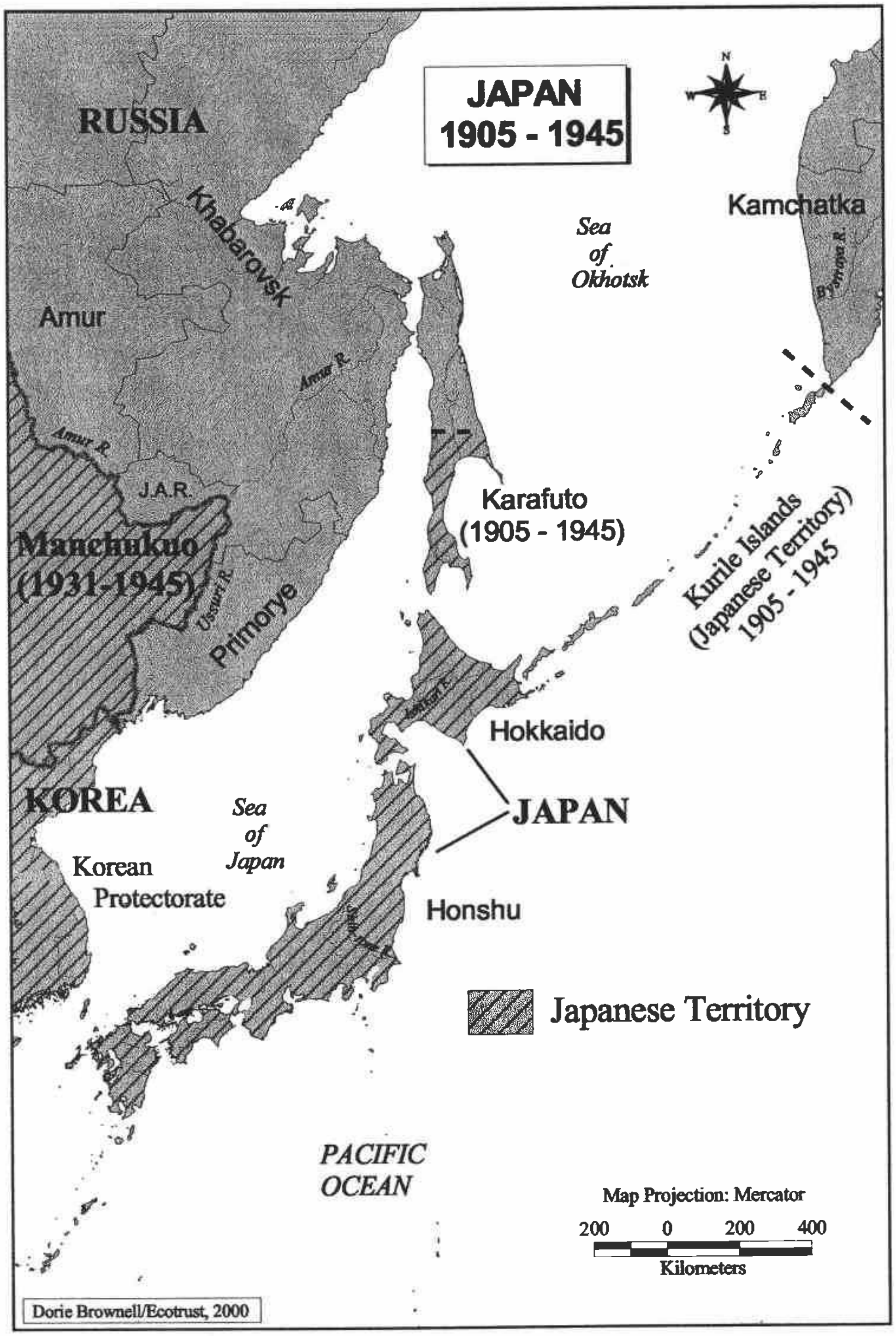

Figure 8.1. Japanese territory between 1905-1945. Sources: ESRI Digital Chart of the World, Pyle (1978), Stephan (1994).

Volkov (1980,194) states that Russia extended its territorial sea from 3 to 12 nautical miles in 1909. Japan protested, but the Russian government assured Japan that they were not extending fisheries rights in contravention of the 1907 Fisheries Convention (Mandrik, 1994). In reality, the tsarist regime may have simply extended their customs authority, as there are additional references to the extension of a 12-mile territorial sea in the 1960s.

8.3.2 Struggling to Share Fraser River Salmon Stocks in the Eastern Pacific

By 1901, the 149 licensed net traps in Washington harvested enough sockeye for the Washington canners salmon pack to exceed the Canadian pack by almost 1,000 cases. Even although the Canadians amended their harvest regulations to permit net traps on the approach to the Fraser in their waters, the imbalance remained. Negotiations to resolve the dilemma were quickly elevated to the level of federal governments, and the US-Great Britain Fisheries Convention was signed in 1908. The United States did not ratify the treaty, because the Washington State Congressional delegation opposed it on the basis of states' rights to manage fisheries. Canada abandoned the treaty in 1914 (Lichatowich, 1999, 176-77; Mighetto and Ebel, 1994, 184).

8.4 1915-1946

8.4.1 Soviet-Japanese Harvest Arrangements

Japan took advantage of the turmoil in Russia after the October Revolution of 1917, and was one of the principal intervention powers during the ensuing Russian Civil War. The Japanese Occupation Army, in addition to supporting White Russian governments in Vladivostok and Khabarovsk, supervised an extensive Japanese fishery in the Amur River basin and on Sakhalin Island during the intervention (1918-1922) (Eniutina, 1974; Mandrik, 1994, 82-83). Japanese imports of fresh chum salmon increased, as the Amur River fisheries were only a 4-5 day steamboat trip from Japan (Baievsky, 1926, 53).

Japan negotiated with both the Far East Republic (the Soviet puppet government based in Siberia) and with the various White Russian governments in Vladivostok, playing them against one another in order to maintain maximal access to Russian fisheries. The Russians were powerless to exclude the Japanese harvesters in the face of Japanese threats to blockade the Volunteer Fleet, the only Russian fleet which could tender and transport Russian fish products (Mandrik, 1994, 80-84). By the end of the Civil War, most fisheries were Russian only on paper. Even in non-Convention waters, most Russians either worked directly for Japanese companies or sublet their leases to the Japanese (Vakhrin, 1996a, 85).

Russo-Japanese fishery relations were somewhat chaotic in the early 1920s, with Japanese fishing rights renegotiated on an annual basis. The Soviet government respected Japanese capital, technology and labor, and knew that it could not afford to eliminate Japanese harvesting and processing operations from its waters. All previous international agreements were annulled by a 1923 decree, "On the order of exploitation of fish and game resources in the Far East". Concessions in Convention waters could now be purchased at auction by either Russians or foreigners (Mandrik, 1994, 101).

A Joint Commission was established in 1923 to resolve war reparations issues and to negotiate the renewal of the 1907 Convention (Mandrik, 1994, 174-76). A Soviet-Japanese Joint Commission was established in 1923 to make arrangements for fisheries-related war reparations and repayment of war-time concession fees, as well as to renegotiate the 1907 Fisheries Convention. The Japanese lobbied for a flat-fee lease arrangement, with no auction. They were unhappy with the approach announced for the 1923 season: competitive bidding, additional taxes, harvest quotas and processing limitations. Japan still had a great deal of negotiating power, and the Soviets waived hatchery and local taxes and leased a set number of concessions at a fixed rate for the 1923 season.

The compromise framework was retained for 1924, and formalized in an interim Convention signed in 1925 (Mandrik, 1994, 174-176). The Convention

Embodying the Basic Rules of the Relations between Japan and USSR was signed in 1925, codifying the 1923-24 status quo with regard to the fisheries (Miles et al., 1982, 530). A new 12-year Soviet-Japanese Fisheries Convention was signed in 1928, stabilizing Japanese investments in Soviet fisheries. The new Convention required Japanese companies to import their own labor (Vakhrin, 1996a, 126). Despite the new Convention, there were occasional disputes and even naval skirmishes over Japanese coastal harvests through 1930 (Hayashi, 1991).

Unfortunately for Japanese fish merchants, Stalin took over leadership of the Soviet Union in 1928 and ended the "New Economic Policy" with its reliance on foreign capital. Japanese shore-based operations persisted on the Kamchatka Peninsula, but the labor force was converted from Japanese to Russian by 1933. Mothership operations within Russian waters were rapidly reduced year to year as well (Vakhrin, 1996c, 26).

Japanese fleets employed several strategies to compensate for reduced access to Soviet territorial waters. The undeveloped Kurile Island fisheries were an obvious subsitute. Hokkaido-based southern Kurile trap and gillnet fisheries grew rapidly in the early 1930s. Shore-based trap-net and gillnet fisheries on the northern Kuriles began shortly thereafter (Shepard et al., 1985b). By 1935, Japanese Hokkaido-based gillnetters were fishing for sockeye outside Soviet territorial waters off Kamchatka (Vakhrin, 1996c, 27). The first exploratory mothership expeditions (floating processors accompanied by drift gillnet vessels) in the Bering Sea and Bristol Bay were made from 1937-39. This fishery was not pursued because of strong US objections (Shepard et al., 1985b; Mathisen and Bevan, 1968). The Japanese instead concentrated a mothership fleet just outside of the Soviet territorial sea (Hayashi, 1991).

The Soviet-Japanese Fisheries Convention was extended by protocol in 1936, and annually thereafter through 1944. World War II did not initially affect Japanese fisheries in Soviet waters. Japanese salmon and crab lease concessions were very lucrative for the Soviet Union, earning more than 3.6 million rubles plus land rents for the Soviet government in 1944 (Vakhrin, 1996c, 30-31). That year, the Soviet-

Japanese Fisheries Convention was extended for another five-year term. Relations with Japan became hostile after the Soviet Union signed the Yalta Agreement in 1945, and the United States bombed Hiroshima.

Japan declared war against the United States and Great Britain in 1941 (Japan Fisheries Association, 1998). There was a slow-down in all of Japan's distant water fisheries at the time, as fuel resources were needed elsewhere. After the United States bombed Hiroshima, the Soviets took over all Japanese fisheries infrastructure on Kamchatka, forced the Japanese off of Sakhalin Island, and took possession of the Kurile Islands as well. The Kamchatka fishing fleet took part in these military maneuvers. On Kamchatka alone, the Soviets inherited 34 canneries, 74 fish processing bases, several cold storage plants, and other support buildings (Vakhrin, 1996c, 30-31).

8.4.2 Working toward the Fraser River Convention

Events on the eve of WWI sharpened Canadian and US interest in coming to an agreement regarding salmon management. The US and Canada were waging ongoing tariff battles, trying to discourage the delivery of raw salmon from their waters to canners across the border. Federal jockeying on behalf of their respective salmon industries was particularly intense during WWI, because of hot salmon markets. Events on the Fraser River also catalyzed negotiations between the United States and Canada. While dynamiting a pass for a new railway in Fraser Canyon, workers precipitated several channel-blocking slides – the best known being the Hell's Gate rockslide. The slide obstructed the passage of commercially important sockeye salmon runs. The true extent of the impact was not felt until 1917, when the cyclical peak in sockeye runs should have occurred. In 1918, representatives of Great Britain and the United States met to formulate Fraser River-Puget Sound salmon harvest guidelines for sockeye stocks (Marchak, 1987, 155; Lichatowich, 1999, 178).

The parties achieved agreement in 1918. In addition to harvest guidelines, a new salmon commission would coordinate life history, habitat and hatchery research. The Canadian government quickly ratified the treaty and drafted implementing regulations. Once again, Washington State intervened in opposition to the treaty, because of the strength of the canners' lobby. It was renegotiated and signed again in 1930, but in the interim a new interception fishery had developed on the US side of the border. Purse seiners had begun to harvest Fraser River sockeye in international waters outside the 3-mile jurisdiction of Washington State. They opposed the creation of an independent commission with authority in international waters and the stipulation for a 50-50 harvest share between Canada and the United States.

The "Convention for the Protection, Preservation and Extension of the Sockeye Salmon Fishery in the Fraser River System", or the Fraser River Convention, was ratified by the United States in 1937. The US Congress ratified the Convention only after the political and economic balance in the fisheries changed in Washington State. Using the initiative process, voters banned fish traps and other fixed gear and required more stringent regulation of the Puget Sound fishery in 1934. Suddenly roles were reversed. Without net traps, Washington State canners took less than half of the Fraser River sockeye run in 1935, and the 50-50 allocation looked appealing. The following year the imbalance was highly skewed in favor of Canadian harvests, likely because prevailing near-shore ocean conditions caused the sockeye to return via Johnstone Strait north of Vancouver Island, rather than by their more frequent southerly route through Puget Sound (Lichatowich, 1999, 178-179).

The treaty mandated an eight-year study period (two sockeye generations) prior to the development of any new regulations. Lichatowich (1999) interprets this requirement to represent the wisdom of Canadian biologists and negotiators, who placed a high value upon knowledge of salmon life history. Crutchfield and Pontecorvo (1969, 141) are more cynical. They interpret the waiting period as a concession to the strong Washington State fishing lobby, delaying the onset of treaty-based regulation.

Life history investigations of Fraser River sockeye salmon were conducted during WWII and Hells Gate fish ladders were completed with US technical assistance by 1945 (Mighetto and Ebel, 1994, 184). The newly created International Pacific Salmon Fisheries Commission (IPSFC) had planning but no enforcement authority.

The Commission did not begin to manage the fishery until 1946 because of WWII (Twitchell, 1989; Healey, 1993, 250).

8.5 1947-1975

8.5.1 State-of-Origin Principle Emerges to Restrict Japanese High Seas Harvests

The Allied Occupation Administration, led by US General McArthur, governed Japan in the aftermath of WWII. Distant water fisheries were shut down. The Allied Occupation Administration instituted the "McArthur Line" in September 1945, to preempt the Japanese from fishing the high seas in the Bering Sea and along the Aleutian Islands. The McArthur Line was relocated several times, resting at 145° E longitude. It excluded Japan not only from areas off the US territorial sea but from many traditional high seas fishing grounds in the present-day Japanese Exclusive Economic Zone (Hayashi, 1991).

The McArthur Line was lifted in 1952, and distant water salmon fishing resumed under the terms of the *International Convention for the High Seas Fisheries of the North Pacific Ocean* (also referred to as the *Tripartite Convention*, for its three members – Japan, Canada and the United States). The principal objective of the Tripartite Convention was to protect common North Pacific fish resources. The US and Canada were particularly interested in protecting salmon, herring and halibut resources from over fishing by the Japanese (Hayashi, 1991).

Fisheries resources were to be protected on the basis of the "abstention principle". Subject to revisions in terms of species, area and season based on research conducted by the three countries, the Japanese fleet was to abstain from fishing east of a provisional boundary line. Sockeye salmon was the immediate concern, and initial research efforts focused heavily on methods to determine the continent of origin of sockeye salmon, and the degree of intermingling of Asian and North American stocks on the high seas. The 175° W meridian was selected as a provisional abstention line, to be modified by research coordinated by the newly created International North

Pacific Fisheries Commission, based in Vancouver, Canada (Figure 8.2). Although subsequent research indicated that there was a substantial zone of intermingling and the abstention line did not protect all Bristol Bay sockeye stocks, harm could not be proven "beyond a reasonable doubt", thus the provisional line became permanent (Miles et al., 1982, 55-63).

Japan's new mothership fisheries were no longer stationary processing platforms. They were mobile factory ships that could follow the fish runs. The Japanese fleet had expanded to 19 of these vessels by 1956 (Hayashi, 1991). The mothership fleet, along with land-based drift gillnet and long-line fleets, fished for salmon west of 175° W in the North Pacific, in the Sea of Okhotsk, and along the eastern shores of the Kurile Islands outside the Soviet territorial sea (Shepard et al., 1985b). Although Japan never fully accepted the abstention principle as a legitimate doctrine of international law, it did abide by the Convention after an initial period of adjustment (Hayashi, 1991).

The Tripartite Convention also gave Canadian and US fishers reciprocal harvest rights within each other's national waters (3 miles). Canadians were to voluntarily abstain from the Bristol Bay fishery in Alaska (Marchak, 1987, 158). The Convention did not resolve all the ongoing tensions between the United States and Canada. There was an ongoing battle between British Columbia and Washington harvesters over Fraser River pink salmon at the time and Canadian harvesters were pushing for inclusion of pink salmon in the Fraser River Convention. The Convention was expanded to include pink salmon in 1957 (Meggs, 1991, 165-165; Crutchfield and Pontecorvo, 1969, 131).

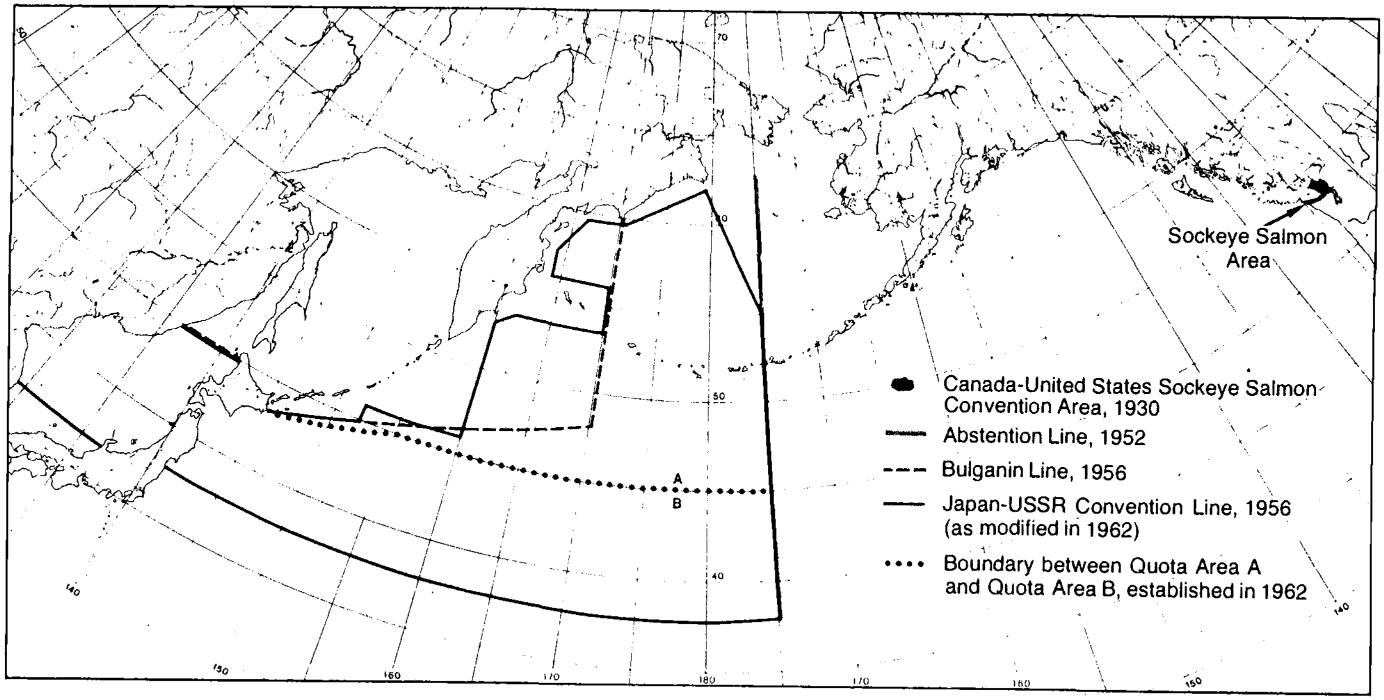

Fig. A.2. *Salmon Regulatory Areas in the North Pacific Prior to Extended Jurisdiction.* Sources: *Canada–U.S. Sockeye Salmon Convention Area*—Drawn on the basis of Article 1, "Convention for the Protection, Preservation and Extension of the Sockeye Salmon Fishery of the Fraser River System 1930," available in *League of Nations Treaty Series*, Vol. 184, pp. 305 ff. *Abstention Line*—Drawn on the basis of Annex, to "International Convention for the High Seas Fisheries of the North Pacific Ocean 1952," available in the *United Nations Treaty Series*, Vol. 205, pp. 81 ff. *Bulganin Line*—Hiroshi Kasahara, "Japanese Distant-Water Fisheries: A Review," *Fishery Bulletin*, 70, 1 (1973), p. 240. *Japan–USSR Convention Line (as modified 1962)*—R. A. Fredin, et al. *Pacific Salmon and the High Seas Salmon Fisheries of Japan*, processed report (Seattle: Northwest and Alaska Fisheries Center, December 1977), p. 73. (See *Atlas of Marine Use in the North Pacific Region*, p. 6, accompanying this volume, for a more detailed map.)

Figure 8.2. Salmon regulatory areas in the North Pacific prior to extended jurisdiction. Source: Miles et al. (1982, 514).

8.5.2 The Soviet Union Responds to the New Principle

Just as it appeared that high seas access issues had been resolved, the Soviet Union made moves to protect Soviet-origin salmon. As Japan prepared for its largest distant-water fishing season yet in 1956, talks on normalization of Soviet-Japanese relations broke down over the Kurile Islands. The Soviet Union issued a decree that became known as the "Bulganin Line," proclaiming the Sea of Okhotsk, an area off the east coast of Kamchatka and the Kurile Islands off limits to the Japanese in the absence of Soviet permission to fish. The decree also set seasons and harvest limits for salmon in the closed area (Hayashi, 1991). Negotiators for the two countries speedily negotiated the *Convention concerning the High Seas Fisheries of the Northwest Pacific Ocean between Japan and the Soviet Union*, which entered into force in December 1956. The Japanese fleet was allowed to fish under an interim agreement during the 1956 season.

For the first time, Japanese vessels were excluded from the Soviet territorial sea and internal waters of the Soviet Union. Time and area regulations for Japanese fisheries on salmon of Soviet origin were contained in the Annexes to the Convention, which were renegotiated annually by the Japan-Soviet Northwest Pacific Fisheries Commission on the basis of coordinated scientific research (Hayashi, 1991, 348-349). Salmon harvest quotas diminished throughout the 1960s, and annual negotiations between Japan and the Soviet Union were very contentious, lasting several months and often resulting in elevation of matters to the Ministerial level (Miles et al., 1982, 73). According to the Japan Fisheries Association, 1957 was the peak year for distant-water salmon harvests, with sixteen fleets operating in the North Pacific (Japan Fisheries Association, 1998). By 1962, the Soviet Union had closed all of the Sea of Okhotsk, the Sea of Japan north of 45° N latitude and the western Bering Sea around Kamchatka to Japanese salmon fleets. Harvests were regulated by annual quotas in two Convention areas in the North Pacific (Hayashi, 1991, 345).

Although Soviet-Japanese issues were the major Pacific international fisheries issue in the 1950s, the Soviet Union also addressed transboundary issues on the Amur

River for the first time. The Soviet Union and the new Peoples Republic of China signed a series of agreements regarding joint economic development, navigation and fisheries in the shared Amur River Basin in the mid-1950s. All of them were short-lived, however, because of the falling out between the neighboring countries early in the next decade. Data were very poor regarding Chinese fall chum harvests on the Amur and the Ussuri rivers, which form the international border. After the collapse of foreign relations, Soviet fisheries managers took advantage of the lack of data and blamed declining Amur salmon harvests primarily on the Chinese (Zolotukhin et al., 1997, 73-76).

8.5.3 United Nations Law of the Sea Negotiations Create New Legal Concepts

The first round of the United Nations Convention of the Law of the Sea occurred from 1958-1960 and resulted in several conventions regarding territorial seas, contiguous zones, the continental shelf and conservation of living marine resources. In response to these conventions, the United States, Canada and the Soviet Union adopted domestic implementing legislation regarding national jurisdiction over mobile and sedentary living marine resources on the continental shelf. This was the first de facto extension of fisheries jurisdiction, as it stipulated the negotiation of bilateral fishing agreements if a foreign country wanted to fish the continental shelf area contiguous to another country's territorial sea. Alaska benefited most from the new conventions, because of the breadth of its continental shelf in the Bering Sea (Pennoyer, 1978, 23). Given the inequality of the continental shelf approach to jurisdiction, it was abandoned in subsequent Law of the Sea negotiations in favor of a standard-width fisheries conservation zone (Marchak, 1987, 164). Nonetheless, continental shelf statutes remain on the books in the salmon countries of the North Pacific.

Canada unilaterally proclaimed a 12-mile fisheries conservation zone pursuant to the new conventions in 1964, and the US followed with a 9-mile fisheries zone in 1966. The two countries immediately became embroiled in maritime boundary disputes. The Pacific fisheries dispute was complicated by differences in wholesale fish prices in the two countries, drawing raw Canadian fish to US processing plants. In order to protect the BC canning sector and harvest access for both countries' fleets, the two countries signed a reciprocal fisheries agreement in 1970. Canadian and US fishers were permitted to harvest in the others' 3-12 mile contiguous fishing zone with the understanding that any reciprocal fishing would not lead to an overall increase in the intensity or spatial area of harvest. Secondly, the Canadian Fisheries Act was amended in 1970 to prohibit the export of unprocessed salmon and herring (Twitchell, 1989; Marchak, 1987, 159-160).

8.6 1976-2000

8.6.1 Canada and the United States Struggle Over Trade Barriers

The 1970 Amendment to the Fisheries Act was struck down by a 1987 ruling on a US petition to the General Agreement on Tariffs and Trade (GATT) review committee. Canada replaced the processing rule with one requiring that all Canadian salmon and herring had to be landed in Canadian ports in order to maintain statistics adequate for monitoring and conservation planning. The US challenged the landings requirement before the dispute resolution panel of the Canada-US Free Trade Act. In 1989, the panel once again struck down the Canadian landings requirement, disregarding UNCLOS III 62(4)(h) language regarding monitoring programs for conservation. The two countries negotiated a solution in 1990, requiring an exemption of a small proportion of Canadian harvest from the landings requirement, with the stipulation that harvests would be subject to verification or sampling at sea or on land (McDorman, 1991).

The US-Canada Reciprocal Fishing Agreement was renegotiated to account for the new Fishery Conservation Zones. However, the anadromous salmon "state-of-origin" principle under debate in the UNCLOS III negotiations in New York became a factor in the negotiations, as the United States had embedded it in its new fisheries law in 1976. Both countries realized that the status quo reciprocal fishing agreement would soon be inadequate to handle the sensitive conservation and allocation issues regarding Canadian-origin Fraser River salmon, US-origin Columbia River salmon, and other shared salmon runs. The discomfort affected hatchery operators in particular. Several new hatcheries were in the planning stages in each country, but neither government was willing to make the capital investment if its fishers would not reap the benefits under the International Pacific Salmon Fisheries Commission regime. The two countries began to negotiate a new framework for management of shared salmon stocks (Twitchell, 1989).

8.6.2 Extended Jurisdictions

The third round of United Nations-sponsored negotiations regarding the Law of the Sea began in 1974 in New York City (UNCLOS III). The negotiations were a delicate balancing act among coastal states and distant water fishing states. Canada and the United States, were successful in arguing for the "primary interest and responsibility" of coastal states for anadromous fish runs from their rivers as embodied in the Tripartite Convention, resulting in Article 66 of UNCLOS III. The spatial extent of coastal state fishery jurisdiction was still a matter of heated debate, but the concept had become accepted. South American coastal states were the first to extend fisheries jurisdiction to 200 nautical miles, and were followed shortly by the United States and the Soviet Union in 1976, and Canada and Japan in 1977 (Figure 3.2) (Miles et al., 1982, 554-556; Volkov and Bekiashev, 1980, 216-217).

Because of its extensive distant water fleet, Japan passed the Provisional Measures Relating to the Fishing Zone with reluctance in 1977. Companion laws extended Japan's territorial sea from 3 to 12 nautical miles except for certain straits, and established an enforcement regime for the new fisheries conservation zone (Akaha, 1985, 135-136, 140). The Fishing Zone law prohibited foreign fishing within the Japanese 12-mile territorial sea, but did not include western or southwestern waters, in order to avoid jurisdictional battles with South Korea and China. Nationals from those countries were exempted from the new foreign fishing prohibition. Akaha states that one of the principal objectives of extending jurisdiction was to keep Soviet and South Korean fleets from impinging on Japanese coastal fisheries (Akaha, 1985, 126).

Extended jurisdiction required that the North Pacific nations reexamine their bilateral and multilateral treaty obligations. The Soviet Union and Japan signed two new fishing agreements in 1977, one regulating Japanese harvests within the Soviet EEZ, and the other regulating Japanese harvests of Russian-origin salmon within the Japanese EEZ. The two agreements were merged into a new Japan-Soviet Fisheries Convention in 1984 after both countries signed UNCLOS III. Japan and the Soviet Union acknowledged the other's jurisdictional claims over the Kurile Islands/Northern Territories in the treaties, but explicitly stated that these claims did not set any jurisdictional precedents. The 1984 Convention prohibited Japanese harvest of Soviet-origin salmon stocks outside of the Soviet EEZ, except in cases of severe economic dislocation for Japan. The USSR embarked upon a program of decreasing Japanese quotas for directed fishing within its EEZ, on the high seas and on Russian-origin salmon within the Japanese EEZ. Japanese harvests of Russian-origin salmon declined by two-thirds between 1985 and 1991 (Hayashi, 1995, 350; Ginsburgs, 1987, 224, 257-258; Akaha, 1985, 146).

Japan and the Soviet Union also developed closer economic and technological ties during this period. The USSR and Japan established Fisheries Attaché positions in their respective diplomatic missions in the other's capitol, to improve communications and reduce the need for the elevation of fisheries matters to the ministerial level. The two countries also signed an agreement on cooperation in fisheries, which led to increased Japanese assistance with hatchery construction and renovation in the Russian Far East (Ginsburgs, 1987, 91, 104).

Shortly after proclaiming a 200-mile Fishery Conservation Zone (1976), the United States announced its intent to withdraw from the Tripartite Convention, forcing a renegotiation in 1978.[26] The abstention principle was dropped, replaced with a set of

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26 Creation of the 200 mile zone is estimated to have reduced the effects of Japanese high-seas salmon fisheries on Alaska stocks by up to 80% (Pennoyer, 1978, 24).

prohibited areas, vessel, and season limitations. The new Convention prohibited Japanese salmon gillnet harvests west of 175° E longitude, except in the central Bering Sea. It allowed for limited salmon fishing within the US EEZ, pursuant to bilateral agreement (Governing International Fishing Agreements, or GIFAs) and the appropriate permits. Amendments to the Convention in 1987 further restricted Japanese fishing in the Bering Sea. The net result was that the new closed area was extended westward by 10° of latitude, largely on the basis of International North Pacific Fish Commission research regarding sockeye migration and nation of origin (Wilkinson and Conner, 1983, 68).

8.6.3 Law of the Sea Negotiations Establish New International Law

The third United Nations Convention on the Law of the Sea (UNCLOS III) concluded its work in 1982, finalizing language regarding anadromous fish that was rapidly adopted by many countries as customary international law.[27] Article 66 of UNCLOS III gives the state of origin of salmon stocks the primary interest in and responsibility for anadromous salmon management. Canada strongly supported this provision, as it strengthened Canadian arguments for control over its vital Fraser River salmon runs, which were also fished by Washington State fishers.

There are still several unresolved issues regarding interpretation of the state-of-origin provision. Two problems immediately arose. First, a state of origin (e.g., Canada) cannot enforce its management regime outside its 200-mile EEZ unless there is an agreement in force with the fishing vessel's flag nation. Second, it was unclear whether state-of-origin authority extended to fisheries with an incidental take of salmon, or directed fisheries only (e.g., the Japanese squid drift net fishery). Nonetheless, Canada, Japan and the United States all adopted import prohibitions against salmon harvested by Taiwan on the high seas "illegally", without permission

[27] Canada signed UNCLOS III in 1994 and has not yet formally ratified the treaty. Canada became a "provisional member" in the International Seabed Authority in 1998 (United Nations, 1999).

from the states of origin. The Canadian Department of National Defense was employed to conduct aerial surveillance of the high seas squid fleet, to watch for vessels straying into migration routes for Canada-bound salmon (McDorman, 1991).

8.6.4 Moratorium on Large Scale Pelagic Driftnets on the High Seas

The international environmental community began a major campaign against high seas drift gillnetting in the 1980s, because of the by-catch of marine mammals, sea birds, and non-target fish species. The primary target of the high seas large scale driftnet fishery was squid. The environmental community formed an alliance with coastal states' fishing sectors, as harvesters from the United States, Canada, Russia and south Pacific nations were concerned about unfair competition and interception of fish destined for their coastal fisheries. The Japanese driftnet fishery within the US EEZ became embroiled in US politics involving the issuance of incidental take permits under the Marine Mammal Protection Act, and was thus virtually eliminated by the end of the 1990 fishing season (Hayashi, 1991, 351).

The broad sentiment against high seas drift gillnetting resulted in two changes in the legal framework for high seas fishing. The United Nations adopted Resolution 44/225 in 1989, recommending a phase-out and then a general moratorium on large-scale pelagic driftnets. This was a consensus-based resolution, modified by a Japanese request for a UN Fisheries and Agriculture Organization (FAO) study prior to a complete moratorium. Despite strong Japanese protests and the inconclusiveness of the FAO study, the UN General Assembly banned the use of driftnets 1.55 miles in length or greater on the high seas (Hayashi, 1991, 357-359; Murdo, 1995).[28]

8.6.5 Multilateral Convention Bans All High Seas Salmon Harvests

In 1988, the Soviet Union announced its intent to ban all high seas Japanese fishing on Soviet-origin salmon stocks by 1992 (Hayashi, 1991, 351). Simultaneously, the United States and the Soviet Union formed an Intergorvernmental Consultative

[28] Japan ratified the United Nations Law of the Sea III Convention in 1996 (United Nations, 1999).

Committee regarding North Pacific fisheries issues, including the development of a new convention to prohibit all high seas salmon fishing.[29] In essence, this would be a successor to the Tripartite Convention, including the Soviet Union for the first time. Canada was enthusiastic, but Japan was understandably reluctant to negotiate the total cessation of its high seas salmon fisheries (Hayashi, 1991, 355-356).

In the interim, the United States and Russia agreed, through an Exchange of Notes, to new limits upon the harvest of Pacific salmon within their waters and on the high seas. The parties agreed to prohibit directed salmon fishing beyond 25 miles from shore in Alaskan waters and in Russian waters north of Cape Olyutorsky. (I.e., within an area bounded by 170°E longitude to the east, 50°N latitude to the south, and the baselines of the territorial seas along Russia and the United States). It is likely that the exchange was initiated by the United States, to protect US-origin salmon. At the time, there was only one Japanese-Russian drift gillnet joint venture operating within Russian waters, and no Russian large-scale drift gillnet operations. With the upsurge in Japanese and Russian drift gillnetting within Russian waters in the mid-1990s, the US fishing industry has become very concerned about interceptions of Bristol Bay sockeye salmon, the highest value Alaskan salmon fishery (Alaskan Independent Fishermen's Marketing Association, 1999, 14).

Shortly thereafter, the four North Pacific salmon nations signed the *Convention for the Conservation of Anadromous Stocks in the North Pacific Ocean*, prohibiting all high seas harvest of Pacific salmon. The Convention does not dictate a set of common standards regarding salmon management within country boundaries. The Convention entered into force in 1993 (Figure 3.2; North Pacific Anadromous Fish Commission, 1994 #770, 1).

The parties have subsequently used the Anadromous Stocks Convention to actively monitor and prevent high seas fishing on the part of signatory and non-signatory nations, despite the tenuous legality of imposing Convention rules on non-

[29] The Intergovernmental Consultative Committee (ICC) is still in existence, meeting approximately annually in Russia and the US. The US delegation has an advisory board consisting of industry and agency personnel from Alaska and Washington.

signatory countries. Drift gillnetters from the People's Republic of China are some of the more frequent violators of the Convention. When apprehended, China does not acknowledge the vessel registration of fishing boats apprehended, rendering them "stateless". It is then possible for crews to be prosecuted under US (or other countries') national laws (Phillips, 1999).

Prior to the new Convention, the North Pacific salmon countries used economic tools to limit high seas salmon harvests. For instance, Japan joined with Canada and the United States in 1985 to restrict Taiwanese fish imports in retaliation for Taiwanese salmon drift gillnetting on the high seas (McDorman, 1991).

8.6.6 Post-Soviet Fisheries Arrangements

The new Russian Federation honored the framework 1984 Fisheries Convention with Japan. Quotas for Japanese driftnetters targeting Russian-origin salmon within the Japanese EEZ continue to be negotiated annually by the Joint Russo-Japanese Fisheries Commission. Allocations for the interception fishery in Japanese waters have declined over the past decade, while quotas for a new Japanese fishery within Russian waters have increased (Knapp and Johnson, 1995, 24).

Immediately prior to the collapse of the Soviet Union in 1992, the only Japanese fishery still permitted within the Soviet EEZ was a joint venture with Sakhalin authorities, whose quota was set annually by the Joint Commission (Hayashi, 1991, 350-351). Japanese drift gillnetters, members of the National Federation of Salmon Drift-net Fishery Cooperatives (Zenkeiren), became proactively involved in Sakhalin fisheries, in order to substitute direct access to Russian salmon stocks for their former interception harvests prior to the North Pacific Anadromous Fish Convention. Zenkeiren formed a Sakhalin joint-venture company called Pelenga-godo, which renovates and builds modern hatchery facilities in exchange for salmon allocations within Soviet waters. Pelenga-godo began operations in 1988, and Zenkeiren has since expanded its operations to other territories within the Russian Far East (Knapp and Johnson, 1995, 28-29).

Privatization of the Russian fishing industry after 1992 led to a variety of foreign fishing ventures within the Russian EEZ, primarily with Japanese, US and Korean partners (GLOBEFISH, 1994, 39-40). Since 1993, Russia has negotiated direct fishing quotas for Japanese harvesters in Russian waters via the standing Joint Russo-Japanese Fisheries Commission. Non-Japanese foreign and joint venture companies negotiate annual quota agreements with Roskomrybolovstva on a year-to-year basis (Knapp and Johnson, 1995, 23).

The policy shift favoring interception harvests within the Russian EEZ to those within Japanese waters and the approval of additional foreign direct fisheries has led to federal-regional strife within Russia. Although total legal interception harvests have not increased greatly in the 1990s, and have in fact declined relative to Japanese interception harvests in the 1970s, foreign harvesters are much more visible to Russian Far Eastern fishers and politicians (Knapp and Johnson, 1995, 24). True harvest levels are difficult to assess, as Japanese harvesters have an incentive to under report total harvests, and to substitute high-valued species such as sockeye for low-value legal allocations for pink salmon. Additionally, Russian vessels are known to transfer their harvest to Japanese vessels at sea and to deliver directly to Japanese and Korean ports, leading to further uncounted harvest (Korolyov, 1999b). At-sea transfers are lucrative for Russian harvesters as they allow them to evade steep customs fees and income taxes (Sidorenko, 1998, 9).

Quotas for the new directed fisheries are controlled by Moscow, because they are based on international agreements. The lion's share of the proceeds from quota sales thus flow to organizations and individuals in Moscow. Kamchatka, Sakhalin and other Far Eastern constituent territories do benefit from Japanese and other foreign fisheries, which bring new technology and hard currency into TINRO laboratories, Rybvods, and the fishing industry. However, the territories perceive a loss of control over quota allocation within their borders. The fact that most of the joint ventures are based in Primorsky Territory but conducted in other territories leads to interregional conflict within the Russian Far East. Direct foreign quotas led to the harvest of at least 28,000 MT in 1995 (North Pacific Anadromous Fish Commission, 1999, 1), and represent fish that were unavailable for allocation to local fishing companies in the regions (particularly Sakhalin and Kamchatka). Russia is the only one of the North Pacific countries that permits the use of large-scale pelagic driftnets (15-20 km long) within their EEZ, despite the UN moratorium on the high seas (Kul'bakov and Chernyi, 1997, 46-51).

In 1997, the Russian Federation ratified UNCLOS III, joining Japan as the only North Pacific parties having ratified the international Convention (United Nations, 1999).

8.6.7 New Pacific Salmon Treaty

Canada and the United States signed the US-Canada Interception Treaty in 1982, but it was not ratified by the US Senate because of Alaskan congressional delegation opposition over the treaty-mandated reductions of southeast Alaska chinook harvest. Both BC- and contiguous states-origin chinook are caught during their return migration in the Alaska fishery. Canada threatened unilateral action, and the US Indian treaty tribes sued to extend the Boldt decision to the Alaskan fisheries intercepting Oregon and Washington salmon. Negotiations resumed between the parties, as it was apparent that the 1982 agreement was unworkable. It was another three years before agreement was again reached, with the Alaskans agreeing to ratify the new treaty if the Treaty Tribes dropped their lawsuit (this is known as the "Baldridge stipulation") (Twitchell, 1989). The goals of the new treaty were to prevent overfishing (conservation) and to provide each country with salmon harvests equivalent to the production of salmon from their own rivers (equity) (Huppert, 1995).

The Pacific Salmon Treaty (1985) created the Pacific Salmon Commission, which was to coordinate research and make recommendations for annual harvest regimes for coho, chinook, and chum in addition to sockeye and pink salmon covered in previous US-Canadian agreements. The Treaty also covered all geographic areas where interception fisheries took place, and cooperation in all aspects of fisheries management. The Canadians in essence traded some loss of control over fisheries on their northern transboundary stocks (Taku, Stikine and Alsek rivers) for greater control over their valuable Fraser River sockeye and pink salmon runs. The new agreement gave the United States increased control over British Columbia's south coast fisheries, where many US-bound fish are intercepted (Healey, 1993, 257).

The salmon industry in Washington State was particularly eager to make the new agreement work. The overall value of Washington salmon fisheries has varied with the productivity of Fraser River salmon runs in British Columbia, and with the outcome of successive US-Canada treaties. The Canadian Fraser River watershed produces 80-90% of the pink and sockeye harvested by Washingtonians in the Puget Sound and Strait of Juan de Fuca (Natural Resources Consultants, 1986).

When the Pacific Salmon Treaty expired in 1992, the two parties could not come to agreement regarding the best approach to reach an equitable balance of salmon interceptions. Matters were elevated to the federal level within each country, as it became clear that the entire framework needed to be renegotiated. Given that fisheries authority in Canada is held by the federal DFO, British Columbia's government became very frustrated, as it did not have a formal seat at the negotiating table. On the other hand, the states of Alaska, Washington and Oregon were full participants in the consensus-based US process, and had many disagreements among themselves.

Unfortunately, the Pacific Salmon Treaty process broke down completely in 1993, because of gridlock among the US delegation regarding chinook salmon management and to the "harvest ceiling" approach adopted in the Treaty. The ceilings became the de facto harvest quotas for the sequential chinook fisheries, from Alaska south through British Columbia to Washington and the Columbia River Basin. Because of the inability of the Pacific Salmon Commission to agree upon new chinook ceilings, the original ceilings set during a period of relative abundance in the mid-1980s were actively retained each year through 1993, and subsequently by default. As chinook stocks continued to decline, the ceilings were far too large to rebuild depressed stocks (Rutter, 1997, 361-365).

The salmon dispute with the United States was a high priority issue in Canada. In 1994, Minister of Fisheries Tobin chose a confrontational approach and permitted all-out harvests on Canadian mixed stock fisheries, including US-origin coho and chinook salmon. Unfortunately, the Canadian salmon runs comprising this mixed stock fishery were also in poor condition, and the heavy fishing worsened the situation (Stanley, 1998, 12).

The treaty was successfully renegotiated in 1999. The new agreement modifies the framework for managing shared salmon stocks. It retains the same geographic units, but modifies the Pacific Salmon Commission structure to include a Panel on Transboundary Rivers and a Committee on Scientific Cooperation. The new elements of the treaty are:

1. Long-term fishing arrangements (10-12 years) for all of the shared stocks, with harvest allocations to be based on forecasted abundance and escapement necessary for conservation;
2. Two US Government-endowed funds to be jointly administered by the US and Canada to invest in habitat and stock enhancement, scientific research and management measures in both countries;
3. Formal commitments by both countries to protect and restore salmon habitat (Department of Fisheries and Oceans, 1999b).

The new Pacific Salmon Treaty allocation process will match total harvest levels each year to actual abundance, based on stock forecasts and in-season monitoring. The new approach will require more cooperation in forecasting and in-season management, but should be more equitable for the harvesters and increase escapement for weak runs of wild salmon (Department of Fisheries and Oceans, 1999a).

The US share of Fraser River sockeye will be reduced from 26% to 16.5 % of the run by 2003. The Washington share of the pink fishery will not change (Washington Department of Fisheries and Wildlife, 1999).

CHAPTER 9 DOMESTIC AND INTERNATIONAL MARKET FORCES

Upon the advent of canning technology in the 1860s, salmon markets became international in nature. Salmon could be effectively preserved for long periods and transported vast distances with greatly reduced risk of spoilage. The major salmon markets shifted geographically and in product preference over time. The North Pacific salmon jurisdictions varied greatly in their ability to affect markets for their product.

Market mechanisms predominated over government control of economic forces in all jurisdictions prior to the Russian Revolution, which occurred at the midpoint of this study. Because international markets dominated national markets everywhere except in Japan since the commercialization of salmon fisheries in the second period (1870-1896), the evolution of market forces is grouped across jurisdictions by period in this chapter. This structure is somewhat cumbersome for the Soviet Union, because the trajectory of the Soviet fishery was driven by government control of capital, technology and product markets from 1922 until 1992.

9.1 Pre-1870

Japan was unique among the North Pacific jurisdictions, because it had a very strong domestic market for salmon and salmon by-products as early as the 1700s. Rice agriculture expanded rapidly on Honshu in the 18th century, spurring a great demand for fish fertilizer. Dried herring was the principal input to fish fertilizer, but dried pink salmon was also utilized. The Matsumae feudal domain had lost direct control over Hokkaido trade to subcontracting merchant traders by this time. In the 1780s, Japanese capital, technology and management were combined with Ainu labor (Figure 3.4). The Ainu became wage laborers, frequently under exploitative conditions. New technology in this period shifted salmon fisheries from riverine trap and spear fisheries to estuarine seine and gill net fisheries, and after 1800 to coastal areas using net traps (Kaeriyama, 1989, 627).

Russian Far Eastern fisheries were just becoming commercialized on a local scale in the 1860s, with the new Cossack border settlements and additional military garrisons established along the Amur and Ussuri rivers. Elsewhere in the Russian Far East salmon harvests were still conducted on a subsistence scale.

Russians in Alaska consumed a great deal of salmon and, like the Columbia Department of the Hudson's Bay Company, the Russian-American Company had a monopoly on salmon harvest. The Russians used seines and rock dams to harvest fish, under barter-based "lease" arrangements with the native Tlingit peoples in the area (Figure 3.3; Langdon, 1989, 312-314).

Gold rushes in Canada and the contiguous United States expanded local markets for salmon from 1848 through the 1860s (Parsons, 1993, 1).

9.2 1870-1896

Japanese salmon markets entered the least restricted period in their history after the Meiji Restoration in 1868, and demand for dry-salted salmon and fish fertilizer remained high. Japan began to import Russian salmon from the Amur River fishery and to conduct shore-based salmon fisheries on Kamchatka in addition to fisheries on southern Sakhalin.

Russia's internal markets were still small in the late 1800s. The first three canneries appeared on the Amur River in 1895-96. Business was difficult, because cannery owners did not own their own harvesting capacity, the Russian labor pool was small, critical supplies such as salt all came from abroad, and transportation links with Russian markets were poor. The early markets were regional population centers such as Khabarovsk, Vladivostok and Blagoveshchensk, as well as gold mines, army outposts and prison camps. Most of the capital in the fishery was from Japan, and Japan was the major market. Despite legal prohibitions, the Kamchatka salmon fisheries developed using Japanese labor (Mandrik, 1994, 157; Zolotukhin et al., 1997, 60).

In Canada, canneries were first established in the 1870s on the Fraser River. Financing for the early Fraser River canneries came primarily from British and Yankee traders with direct market ties to Great Britain and New England (Muszynski, 1987, 47-48). Victoria was the center of the early salmon industry, building on financial infrastructure and relationships developed during the Cariboo gold rush and during the heyday of the fur trade. Most of the marketing, transshipment, provisioning, and crew arrangements were made in Victoria. The number of canneries increased rapidly from the 1870s to the turn of the century (Newell, 1989, 12).

By the late 1880s, Canadian banks took financial control of the industry and gave British Columbia processors increased independence from the marketing agents. The commercial center of the fishing industry shifted to Vancouver. This shift was facilitated in part by the completion of the transcontinental Canadian Pacific Railway to Vancouver in 1885, increasing access to Eastern markets. However, British markets and the maritime trade route were still predominant during this period (Muszynski, 1987, 47-48; Newell, 1989, 12).

Canadian markets were determined to a great extent by the United States. Alaskan fisheries produced the largest volumes of Pacific salmon, including sockeye, British Columbia's premiere export. Additionally, Fraser River harvesters and processors were in direct competition with the salmon industry in Puget Sound, which intercepted Fraser-bound sockeye and pink salmon. Because of differential gear regulations, US fishers employing highly efficient fish traps and drag seines had a strong advantage over Canadian harvesters limited to purse seines and gillnets (McMullan, 1987b, 108).

During the late 1800s, the United States emerged as the largest single market for canned salmon, and also exported salmon to Britain, Belgium and Australia (Garrod, 1987, 93).

By the 1890s, cold storage facilities were extending the processing and marketing seasons in all jurisdictions except Russia.

9.3 1897-1914

Japanese markets remained strong throughout the first two decades of the 20th century, but domestic salmon stocks plummeted. The Japanese salmon market was increasingly supplied by Japanese harvesters fishing on southern Sakhalin or elsewhere in Russian waters. During this period, a central wholesale market with government-funded infrastructure was established in Tokyo, to facilitate the rapid and efficient distribution of salmon from distributors to wholesale and retail buyers (Japan Fisheries Association, 1998).

The Russo-Japanese War (1904-1905) helped develop internal Russian markets for salmon. Troops returning home to western Russia took salmon caviar with them, introducing it to a broader western market. Increased western demand coincided with the availability of the new rail route across Manchuria (Chinese Eastern Railway, 1903) and the disruption of Japanese markets to shift salmon production toward internal Russian markets. An increasing proportion of Amur salmon production was brined for the European market, rather than dry-salted for the Japanese (Mandrik, 1994, 52).

Between 1907 and approximately 1912 all of the salmon commercially harvested on Kamchatka was shipped to Japan, but by the eve of WWI the western Russian market was purchasing approximately 20% of the production. Rail tariffs on the Chinese Eastern Railway were lowered, the Volunteer Fleet of schooners and steamships facilitated domestic market development in Russia. The developing transportation network also facilitated the first commercial-scale exploitation of the Anadyr River (Chukotka; Figure 3.12) salmon stocks (Mandrik, 1994, 58).

Kamchatka harvests increased six-fold by the 1913 season (Mandrik, 1994, 54). Among the Russian companies, Demby was the biggest operator, financed largely by the Japanese and Chinese. Demby made the first attempts to freeze salmon, but it did not become a common processing method because of transport limitations (Vakhrin, 1996c, 13). New gas engines increased fishing efficiency. Many Ukrainians initially exiled to the Primorye Province of the Primorye Governor-Generalship moved to Kamchatka to fish, and the starozhily (old-time settlers) and natives increasingly shifted from subsistence and wage hunting to wage labor fishing (Vakhrin, 1996a, 82; Mandrik, 1994, 61).

Aside from Japan, the other major international markets for salmon were in Great Britain and her Anglo colonies. Whereas Japan imported most salmon dry-salted, fresh or reduced as fish meal, Great Britain, Australia and New Zealand imported canned salmon. US and Canadian domestic markets for canned salmon also continued to expand prior to WWI. With the expansion of cold storage facilities, the fresh and frozen salmon market also began to grow. Demand was particularly great in the large population centers of the eastern seaboard of North America and in Europe. Europeans reprocessed frozen salmon as smoked fillets for European consumption.

Fisheries for halibut and bait herring grew alongside the British Columbia salmon fishery, prompting a need for more refrigeration facilities. The increased refrigeration capacity coupled with the introduction of troll fishing opened up the possibility for Canadian and US fresh fish markets for chinook and coho (Newell, 1989). The Canadian Northern Railway (1915) opened a rail line to Vancouver, paralleling the Canadian Pacific Railway (1885) along part of its route. Railway competition lowered freight rates, which helped to open new markets for fresh coho, chinook and halibut in eastern Canada. By 1914, the Grand Trunk Pacific Railway had reached Prince Rupert Island, and it became the principal transshipment point for fresh salmon shipments to the east. Canned pink and chum salmon outstripped the sockeye pack by this time, and diversification enabled many canneries were able to operate several months out of the year (Newell, 1989, 12; Harris, 1997a, 169-171).

The financial and commercial center of the North American salmon industry moved from San Francisco to Seattle around the turn of the century, following the Alaska and Puget Sound fisheries (Newell, 1989). The European market for brined Columbia River chinook peaked prior to WWI and several canneries operated cold storage facilities as well as canning lines to meet the demand. These markets were not regained after WWI (Smith, 1979, 84).

9.4 1915-1946

9.4.1 Global Salmon Markets and WWI

Japanese firms accounted for 85-90% of war-time harvests in Russian waters, becoming the primary exporter of canned salmon products to Britain and the United States during WWI (Vakhrin, 1996a; Mandrik, 1994, 56). Russian salmon fisheries were beset by fuel and labor shortages during the war. Nonetheless, Russian domestic markets continued to grow. Russia relaxed restrictions on foreign labor and by the end of the war more than 50% of the work force in non-Convention waters (waters reserved for Russians under the 1907 Russo-Japanese Fisheries Convention) was foreign, with the exception of the Amur River. The Trans-Siberian railroad terminus in Khabarovsk was completed in 1915, and the rail passage around Lake Baikal was completed in 1916. The completion of the Trans-Siberian Railroad facilitated increased Russian control of the Amur River salmon fishery relative to the Japanese, but the process was derailed by the Russian Civil War (1918-1922).

Canada's fisheries expanded during WWI, in response to the demand for inexpensive canned salmon as a wartime ration. Most of the salmon pack from Canada was shipped to Britain. Markets also expanded in Western Europe, because their accustomed Northern European fish supply was cut off by the war (Muszynski, 1987).

Alaskan and Pacific Northwest harvests also expanded in response to WWI demand. The number of Alaskan canneries almost doubled, increasing from 86 in 1915 to 143 in 1920 (Crutchfield and Pontecorvo, 1969, 96). The vast majority of Alaskan production during WWI was purchased on contract by the US government (Cooley, 1963; Smith, 1979).

9.4.2 International Salmon Markets after WWI

During WWI, all species became a part of the harvest mix in every jurisdiction, as canners strove to maximize canned salmon pack. Prior to WWI, trollers in British Columbia and the Pacific Northwest had already begun to develop a market for fresh and frozen coho and chinook. After WWI, the markets for coho and chinook, whether captured using troll or net gear, followed a separate trajectory than did canned salmon markets. Sockeye, pink and chum salmon, accounting for 80-90% of North Pacific salmon harvests, continued to be processed by canning. Unless otherwise noted, the discussion in this chapter refers to canned salmon market trends.

After WWI international and domestic canned salmon markets softened substantially. The United States government returned unused salmon supplies to the

Alaska canners in 1919, whereas the Canadian government sold off war-time stores gradually. Alaskan canners sold their inventories on the world market below cost, with negative effects on the international salmon prices. Export markets for Pacific Northwest and Alaska salmon were also affected by weak foreign currencies relative to the dollar, and by competition from Japanese canners operating in Russia during the Russian Civil War (Cooley, 1963). The US-wide and Canadian post-war depression (circa 1920-22) contracted North American domestic markets, spurring a round of cannery consolidation in Alaska and the Pacific Northwest (Crutchfield and Pontecorvo, 1969, 96), and strong competition among canneries for fish deliveries and market share in British Columbia (Muszynski, 1987, 56).

Canadian canners began to search for new markets after WWI, because Japanese production was proving a major source of market competition. Canadian markets expanded in Western Europe, Australia and New Zealand. The US canned salmon market was also large, but inaccessible to Canada because of stiff import duties. The Canadian Department of Marine and Fisheries embarked upon a program of domestic market development to assist the industry during the interwar period, and there was a great deal of ownership consolidation among canneries (Newell, 1989).

Following on the heels of WWI, the Civil War (1918-1922) was disastrous for Russian fisheries. The local economy was destroyed, and most residents of the region became dependent on fish and game (subsistence fishing and hunting). Japanese harvests across the Russian Far East during the Japanese Occupation (1920-1922) were limited only by harvest capacity. Japanese merchants initiated direct steamship service between various locations on Kamchatka and Japan to expedite salmon exports (Vakhrin, 1996a, 85). US vessels were also very active off Kamchatka, harvesting both fish and marine mammals (Mandrik, 1994, 91).

The Russian domestic fishing industry had limited fuel and salt, and no means of transporting fish, because most Russian vessels had been captured by France, Japan or the United States, the three major interventionist powers in the Civil War (Mandrik, 1994, 74). In many instances, local Russian harvesters were prohibited from fishing for salmon, crab and marine mammals if it interfered with Japanese "national interests", and their gear was confiscated (Mandrik, 1994, 78-79).

International and domestic market conditions improved around the North Pacific by the mid-1920s and were strong throughout the Great Depression, despite an initial drop between 1929-1931. Canada exported salmon primarily to markets with preferential tariffs for United Kingdom countries, such as Australia and New Zealand. Relative to Alaskan and Japanese production, Canadian canned salmon prices were too high to be competitive in other markets (McMullan, 1987b, 116).

In Alaska, rising salmon prices led to both increased pack and profits coincident with passage of the White Act in 1924. Canners interpreted the increased pack as a triumph of conservation, and sought to maintain their markets by imposing punitive tariffs on salmon packed in Russia and Japan. They also sought to weaken anti-trust laws, in order to legalize informal price collusion (Cooley, 1963).

Japan consolidated its position as the major salmon exporter further in the 1930s, with the creation of a mothership fishery (floating processor accompanied by drift gillnet vessels) off the coast of west of Kamchatka in the Sea of Okhotsk (Figure 3.12). During the Great Depression, Japan's canned salmon pack was much greater than that of the other North Pacific jurisdictions, and all of the pack was destined for export (Garrod, 1987, 93; McMullan, 1987b, 116).

Within Japan, legislation (1933) gave local Fishery Cooperative Associations more control over the disposition of their harvests. The Cooperatives were authorized to sell members' fish, build cold storage and auction facilities. In some areas, local Japanese fishers began to gain better control over their incomes, as middlemen were eliminated from the marketing process (Sato, 1992, 77).

9.4.3 Collectivization of the Russian Salmon Industry

Japanese labor and direct investment were critical to the establishment and rebuilding of the fisheries in Kamchatka and along the Sea of Okhotsk after the Civil War (1918-1922). Given the economic disarray in the aftermath of the Civil War, the Soviet government adopted the pragmatic New Economic Policy (1921-28) to encourage reconstruction of infrastructure, labor training and the production of basic foods using a mixture of private and public capital. Nationally significant fisheries would be nationalized on an opportunistic basis, with fishing rights leased on a preferential basis first to government ventures, followed by cooperatives, public-private partnerships and lastly, to private companies (Mandrik, 1994, 118). Fish could be sold freely on the private market, and private capital persisted although increasingly restricted. (Vakhrin, 1996a, 85; Mandrik, 1994, 95-96). A single Japanese company owned 81% of Far Eastern canneries responsible for 95% of canned salmon production and 20% of the overall salmon harvest in 1926 (Mandrik, 1994, 181).

The government-run fishing sector was frequently reorganized in the 1920s as the Soviet government struggled to keep its state-run businesses going; 1924 was a particularly poor fishing season. The fishing sector clearly had potential as a generator of hard currency, and there were struggles between Moscow and Far Eastern authorities for direct control of the industry. The regional economic authorities based in Vladivostok emerged victorious in these early struggles (Mandrik, 1994, 107-108).

The First Five-Year Plan went into effect in 1928, beginning the collectivization process in fisheries. Integrated native hunting and fishing cooperatives were created throughout the Russian Far East, with structures similar to traditional native village organizations. The new cooperatives preserved family groupings and ties to the land. The organizations were subsidized with hunting and fishing gear and trade goods. Peasant collectives were also created, unifying fishing operations either on a village by village basis or, in the larger settlements, creating several geographically based cooperatives. Shortly thereafter, a series of government fishing enterprises was created throughout the Russian Far East. In contrast to the collectives (kolkhozy) who only harvested fish, the government enterprises were vertically integrated (Zolotukhin et al., 1997).

9.4.4 Global Salmon Markets During WWII

Japan ceased salmon production during WWII, at first because of shortages of fuel and manpower and ultimately after being evicted from concessions in Russian waters. The domestic industry continued to provide a small volume of fish for Japanese markets (Figure 3.8). Japan did not become a factor in international markets again until the 1950s.

The Soviet Union produced salmon primarily for domestic markets, and official harvests rose only slightly during WWII (Figure 3.11). The defeat of Japan in WWII provided a windfall for the Soviet salmon industry. The Kamchatka fishing industry inherited 34 canneries, 74 fish processing bases, several cold storage sites and other support buildings from the Japanese (Vakhrin, 1996c, 30). The situation was similar on southern Sakhalin, but in addition to the processing and storage capacity, the Sakhalin fishing industry also inherited twenty two fish hatcheries (Zhul'kov, 1999).

By the end of the interwar period, domestic consumption accounted for over one-third of Canada's salmon pack, but during WWII Great Britain was the sole market for Canadian canned salmon. War-time canned salmon sales were made directly to the British Ministry of Food, which purchased the entire Canadian pack in 1942. The Canadian government bought the entire pack in 1943, selling a small portion on the domestic market. Requisitions continued on a declining scale through 1946, and markets were guaranteed to canners in 1947 in order to lessen the impact of requisition policies. Canadian processors were eager to satisfy as much British demand as possible, in hopes of regaining markets lost to Japanese Kamchatka production. All forms of salmon processing other than canning were banned during WWII, as were all exports of unprocessed salmon and herring (Newell, 1993, 106; McMullan, 1987b, 113-114).

Canadian subsidy programs for canners (market development) and for harvesters (vessel construction loans) date to the immediate post-WWII period. The Fisheries Price Support Board was created in 1944, to monitor incomes in the fisheries and to further develop domestic markets for seafoods. It was preceded by the Fishing Vessel Assistance Program (1942-75 in the Pacific fisheries), designed to aid fishers in modernizing their vessels (Crowley et al., 1993, 343, 349-50).

World War II affected both management measures and harvests in Alaska. Under intense industry pressure, the new US Fish and Wildlife Service loosened federal harvest regulations in Alaska Territory between 1942 and 1945. Domestic prices for canned salmon were capped by the Office of Price Administration, otherwise WWII might have had more devastating effects on Alaskan salmon stocks through excessive harvests to meet strong market demand (Cooley, 1963, 156-158).

During and after the war, the two Interior Department agencies most active in Alaska Territory carried out dueling policies. The Bureau of Indian Affairs pursued a lending policy to assist native fishermen to purchase more efficient boats and defunct canneries, closed during wartime consolidation. Meanwhile, the Fish and Wildlife Service struggled to legislatively strengthen its authority to regulate harvest, after losing leverage during WWII (Cooley, 1963).

California harvesters were apparently able to take advantage of the tail-end of WWII demand, producing a near-record 13+ million pounds of salmon in 1945 and 1946 (Lufkin, 1991b, 20).

9.5 1947-1975

9.5.1 Planned Investment in Soviet Fisheries

Fishing industry development in the Soviet Union was calculated to provide quality food protein for the masses. The Fourth Five Year Plan (1946-50) was designed to rebuild the Soviet industry. Fishery development and vessel construction were a priority, particularly the development of a distant-water trawl fleet. This emphasis is attributed to two Soviet objectives – the need for large quantities of inexpensive food protein, and the desire to extend a diplomatic and military presence around the world (North Pacific Fishery Management Council, 1997).

The Sixth Five-Year Plan saw a shift of fishing effort into previously under-utilized marine fisheries. The Kamchatka fishing collectives (kolkhozy) took delivery of their first trawlers, and began harvesting fish other than salmon and herring. Government fishing enterprises Primorrybprom and Sakhalinrybprom also began trawling off of Kamchatka at this time (Figure 3.12; Vakhrin, 1996, 33-34). By the late 1950s, Soviet trawlers were equipped with fish-finding equipment and radar navigation, enabling them to travel greater distances and more efficiently locate aggregations of fish (Vakhrin, 1996a, 132).

The Seven-Year Economic Plan (1959-1965) brought about dramatic economic restructuring in the fisheries: salmon processors and canneries were closed down, and many fish harvest collectives (kolkhozy) were either eliminated or relocated to focus on marine fisheries. The decision to shift the fishing industry from salmon to marine fishes was made in Moscow, by the Ministry of Fisheries. From the standpoint of protein production, it paid off handsomely – the production of consumer-ready fish products had increased 40% by 1966, 70% by the mid-1980s. Shore-side canning production tripled, while at-sea canning increased 66-fold (Vakhrin, 1996c, 35-36).

9.5.2 International Markets

Japan continued to produce canned salmon for export into the 1970s, while producing fresh or dry-salted fish for the domestic market. Export production was derived largely from the distant water mothership and land-based drift gillnet and long-line fleets. Canned salmon exports were vital to Japan as they helped to alleviate the chronic foreign trade deficit that persisted until the mid-1960s, earning hard currency for purchase of raw materials for industry (Garrod, 1987, 96).

As a means of diversifying salmon sources, the largest Japanese fishing enterprises began to invest in salmon production capacity in the Alaska and Canada in the 1960s and 1970s. McMullan notes the withdrawal of Japanese equity in BC processing companies between 1972-1979, as Canadian salmon stocks began to decline (1987b, 139).

Canada was the leading exporter of canned salmon during the depression in Alaskan fisheries in the 1950s and 1960s, until the upswing in Alaskan pink and sockeye production in the late 1970s (Garrod, 1987, 100). The largest Canadian salmon canner, B.C. Packers, was purchased by Weston's, an integrated grocery corporation in 1962. Canadian processors turned their attention increasingly to the domestic market for frozen fillets, given the development of transportation and home freezer technology. Substitutes such as canned tuna and breaded white fish fillets led salmon canners to diversify their production and sponsorship of fishing fleets. Combination processing plants began to produce several products (Newell, 1993, 126-127).

The US market for canned pink and chum salmon softened in the early 1950s, because of the increase in affordable substitutes (poultry, tuna, fish fillets). Canned sockeye remained more profitable on the domestic market, because of its richer color, oil content and flavor in comparison to chum and pink salmon. Canned tuna was introduced in the 1950s, and quickly became an inexpensive alternative to canned salmon. Canning began to lose its primacy as the principal processing method in the salmon industry given the change in domestic consumer tastes; the number of canneries in the Pacific Northwest and British Columbia declined rapidly in the 1960s and 1970s.

The Korean War (1950-1953) temporarily boosted prices for canned salmon from British Columbia and Alaska. Great Britain dropped WWII import restrictions on salmon, which had protected Canadian canners, giving Alaskan canners access to more market share. Alaskan canneries continued to consolidate in order to maintain profitability (Cooley, 1963). As of 1971, more than 80% of Alaska's harvest was still canned, and less than 20% sold frozen (Garrod, 1987, 100).

9.6 1976-2000

9.6.1 Japan Becomes the Primary International Salmon Market

After the extension of 200-mile Fishery Conservation Zones in 1976-1977, Japanese canned salmon exports diminished rapidly. Access to the Soviet Fishery Conservation Zone was limited by a new bilateral treaty agreement (1977), and the open access high seas fishing areas diminished under the 1978 amendments to the International North Pacific Fisheries Commission regime. Japanese consumer tastes shifted to include more fresh, chilled or frozen salmon in addition to traditional dry-salted salmon, both because of increasing Japanese incomes and improved flash freezing technology (Garrod, 1987, 98).

In 1977, Japan became a net importer of salmon. Imports have risen steadily since that time. The opening of the Japanese market created a niche for fresh and frozen sockeye and chum salmon, most of which had previously been canned. Initially, Japan imported frozen salmon from Canadian and Alaskan fisheries (Garrod, 1987, 100). In general, Canadian sockeye is preferred to Alaskan sockeye on the Japanese market, due to its higher oil content (Salmon Market Information Service, 1999, 5). In the late 1990s, Russia again became the largest supplier of fresh and frozen salmon to Japan, displacing Alaska. Whereas frozen salmon imports would once have been reprocessed in Japan for the domestic market, the relative consumption of salted salmon has been falling and the consumption of fresh salmon has been increasing in Japan in the 1990s. Domestic chum salmon supplies were adequate to supply the dry-salted salmon market in Japan until 1998; since that time Japan has begun to import frozen chum salmon. Sockeye, chinook, coho and steelhead are preferred on the Japanese market, because of their bright flesh color and high fat content (Kanto and Ishikawa, 1999, 7). Farmed coho, steelhead and Atlantic salmon are now beginning to displace premium wild-harvested sockeye in the Japanese market because of price competition and year-round availability. Japanese hatchery chum salmon is less preferred than wild, due to a lower fat content (Kaeriyama, 1992, 58). Japanese markets have become more price-sensitive since the onset of economic recession in Japan in the early 1990s. Farm-reared Atlantic salmon and coho, primarily from Chile, Norway and Canada, now account for well over 50% of Japan's salmon imports (Kanto and Ishikawa, 1999, 7).

9.6.2 Quasi-Privatization of the Russian Salmon Industry

Mikhail Gorbachev became First Secretary of the Communist Party of the Soviet Union in 1985, and the reverberations were soon felt in the fishing industry. The Ministry of Fisheries ordered Dalryba, the Far Eastern regional harvesting and coordination entity, to be disbanded in 1988. Dalryba was henceforth to manage distant-water fleets, but not to hold assets. The old form of Dalryba was disbanded by 1990 (North Pacific Fishery Management Council, 1997). Boris Yeltsin took power in 1991, after an aborted coup attempt by conservative politicians, and the Soviet Union was disbanded by the end of the year.

After the dissolution of the Soviet Union, all government subsidies were withdrawn from fishing enterprises and collectives and the process of privatization was begun. Fish prices were freed in January 1992, and by the end of the year fishing companies were permitted to retain up to 90% of their hard currency earnings from exports. Ten percent of all fish harvests were to be sold on the internal market (North Pacific Fishery Management Council, 1997). Direct access to international markets has facilitated the accumulation of Russian fishing companies' funds outside of Russia. While the establishment of offshore savings has been a rational response to economic and legal uncertainty in Russia, it has resulted in a loss of capital for investment in Russian Far Eastern fishing industry infrastructure (Zolotukhin, 1996b).

Customs laws in the Russian Federation worsen the situation. Based on the 1995 Customs Code, as subsequently amended, there are five separate classes of harvest and landings with different fee requirements. A great deal of unreported harvest is sold directly overseas, because no customs or clearance fees are charged if the catch is caught beyond the 12 nautical mile territorial sea and is not landed in a Russian port. Vessels either offload their catch illegally to buyers on the high seas, or deliver it directly to Japanese and Korean ports (Vylegzhanin, 1999).

9.6.3 Alaska Reasserts Market Dominance

Prices for wild-harvested Canadian canned salmon collapsed in 1980, because of market competition from rebounding Alaska wild harvests and from Chilean, Norwegian and Canadian pen-reared salmon. Canada was in an economic recession in the early 1980s, and many post-WWII Canadian subsidy programs were eliminated. Pursuant to the Nielsen Task Force (efficiency in government) recommendations in 1984, the Canadian Department of Fisheries and Oceans dropped its marketing and vessel construction programs, and trimmed personnel from research and regulatory units. Prior to the cut-backs, salmon fishery management was deemed to cost more money than the fish harvested were worth (Meggs, 1991, 211; Crowley et al., 1993, 363-364).

Markets for seafood have grown worldwide in the 1990s. The demand for premium seafoods such as salmon remains strongest in the developed countries. Owing in part to a United States industry-sponsored marketing campaign promoting the health benefits of salmon consumption in the early 1990s, per capita salmon consumption in the United States increased 27% over a one-year period from 1994-1995. Other reasons for growth in salmon demand in the United States and other developed countries such as Japan and Canada are improved processing, packaging and increased restaurant dining (Weber, 1997).

The biggest change in both international and domestic salmon markets has been the widespread acceptance of pen-reared Atlantic salmon and coho as substitutes for wild-caught fish.[30] Pen-reared fish are available fresh year-round and available in precise size gradations with reliable flesh characteristics. Farmed fish are particularly attractive to restaurateurs and large wholesale grocery corporations, because of their stable price and flesh quality. Farmed fish was introduced in the late 1970s, but did not begin affect markets for wild-harvested salmon until the mid-1980s (Weber, 1997). Because of the broad appeal and reasonable prices of pen-reared salmon, the United States became a net importer of salmon in 1998, primarily in the form of pen-reared product (Alaska Seafood Marketing Institute, 1999).

Salmon markets in the eastern Pacific were integrated when Canadian tariffs and landing requirements were eliminated pursuant to a US challenge under the North American Free Trade Act in 1990. BC Packers, now a subsidiary of Weston's, a diversified multinational corporation, purchased processing plants in Alaska and Washington. The large, multinational canner began to process salmon wherever it

[30] The term "wild-captured" or "wild-harvested" can be misleading. A high proportion of the "wild-harvested" salmon today, particularly pink and chum, is of hatchery origin. It is harvested in the wild, but not of wild salmon stock, i.e., reproducing in the wild.

appeared to be most efficient, breaking the hold of the UFAWU on the Canadian salmon fishery (Meggs, 1991, 242-243).

Since 1995, there has been a glut of pink salmon on the international market, and prices are so low that it is barely worthwhile for many Canadians and Alaskans to fish for the abundant and low-value fish. Hatchery production of pink salmon in Alaska and Russia (particularly Sakhalin Island) has exacerbated the glut of pinks. In Alaska, canners initially broke contracts with fishers in years of oversupply. More recently, Alaskan aquaculture associations and regional canners have developed contracts guaranteeing markets at fixed prices. Hatchery associations have contracted for chum salmon markets with Alaskan canners, angering wild-captured chum producers in central Alaska whose runs have been more variable over time. Because of transportation costs and the nature of the wild chum fishery, central Alaskan wild salmon fishers have been at a market disadvantage (McGee, 1999).

Wary of competition from farmed salmon and the potential for disease transmission to wild-captured fish, the Alaskan salmon industry banned salmon farming in state waters. The Alaska salmon industry has keenly followed the development of the Russian Far Eastern salmon industry to keep abreast of potential market competition, resulting in a series of reports commissioned by the State of Alaska and the US Congress (e.g., North Pacific Fishery Management Council, 1997; Knapp and Johnson, 1995).

CHAPTER 10 SCIENCE AND ENVIRONMENTAL ACTIVISM

10.1 Japan

10.1.1 Pre-1870

10.1.2 1870-1896

The research and education component of the Japanese fishing industry began to grow quickly after the establishment of the Japanese Fisheries Association (1882) and the creation of the central government's Bureau of Fisheries (1885). The Fishery Training Institute, the predecessor to the Tokyo University of Fisheries, was opened in 1889 to train fisheries professionals (Japan Fisheries Association, 1998).

10.1.3 1897-1914

Hokkaido Prefecture established a Survey Station (1897) and then a permanent Fisheries Experimental Station in 1901. The facility had an applied focus, with its own processing plant. It received funds both from the Prefecture and from the national Fishery Agency. High seas fisheries research was initially conducted from this research institute (Hokkaido National Fisheries Research Institute, 1999). Four other regional fisheries institutes (Tohoku, Seikai, Nansei and the Japan Sea National Fisheries Research Institutes) were established over the next few decades.

10.1.5 1947-1975

The Japanese Diet established the Ocean Research Institute at the University of Tokyo in 1962, to improve oceanographic and marine science education in Japan. The new program was advocated by the Japanese Society of Fisheries Science and the Oceanographic Society (Ocean Research Institute, 1999).

In the late 1960s, high seas research programs at the regional fisheries research institutes were amalgamated into the Far Seas Fisheries Research Laboratory at Shimizu, on the East coast of Japan south of Tokyo. All of the regional fisheries research institutes are organizationally a part of the Japan Fisheries Agency, within the Ministry of Agriculture, Forestry and Fisheries (National Research Institute of Far Seas Fisheries, 1999).

10.1.6 1976-2000

Two additional research units were established within the Japan Fisheries Agency in the late 1970s. The first was the National Research Institute of Aquaculture, created pursuant to the Fisheries Promotion Program adopted earlier in the decade. The Aquaculture Institute increased the profile and funding of artificial reproduction research, in the wake of extended jurisdiction closing off traditional high seas fisheries (National Research Institute of Aquaculture, 1999). The National Institute of Fisheries Engineering was established the same year, to assist the fishing industry with cutting edge harvest and processing technology, and to support aquaculture and fishing port infrastructure (National Research Institute of Fisheries Engineering, 1999).

The Japan Fisheries Agency conducted a review of its research institutes in 1998, and reorganized them to focus on the ocean ecological of particular areas, with the objective of improving research regarding ocean productivity and fish stocks. North Pacific fisheries research is now again housed in the Hokkaido-based research institute, renamed the Hokkaido National Fisheries Research Institute. The Tokai Regional Fisheries Research Laboratory became the National Research Institute of Fisheries Science, and took on the lead coordinating role in the network of fisheries institutes (National Research Institute of Fisheries Science, 1999; Anonymous, 1999b).

Japan, the United States and Canada, were the first signatories to ratify the North Pacific Marine Science Organization (PICES) Convention in 1990. The Peoples Republic of China ratified the Convention the same year, and was joined by the Russian Federation (1994), and the Republic of Korea (1995) (PICES, 1999). Despite turf battles with the new North Pacific Anadromous Fish Commission over salmon-related research, PICES has become the central coordinating body for ocean-atmosphere-living resources research in the region.

There is not a tradition of environmental or civic activism in Japan, and local environmental groups are just beginning to form. Friends of the Earth-Japan was founded in 1980, and although it focuses on fisheries and forestry issues in the Russian Far East, it has not yet undertaken major programs within Japan (Friends of the Earth-Japan, 1999). Small, river-specific Japanese organizations are beginning to organize to prevent further construction of hard engineering structures in stream channels and to protect remaining natural river reaches. The new groups are challenging the virtual hegemony of the Japanese Ministry of Construction over river management and long-term land-use planning (Anonymous, 2000; Anonymous, 1999a).

10.2 Russia

10.2.1 Pre-1870

Early reconnaissance in the Russian Far East included naturalists who described some of the fishes of the region, notably the Pacific salmon on the Kamchatka Peninsula described by Georg Wilhelm Steller (Stearley and Smith, 1993, 4). Both Steller and Kamchatka expedition leader S. P. Krasheninnikov described seven species of salmon, which returned to spawn in freshwater and died after spawning (Borisov, 1964, 11).

10.2.2 1870-1896

Ichthyological studies during this period focused on the diminishing freshwater fisheries in Western Russia (Borisov, 1964).

10.2.3 1897-1914

Newcomers to the Amur River basin recognized the importance of the fisheries to the Far Eastern economy very quickly, and initiated surveys to assess the resources. V. K. Soldatov was the first to begin systematic fisheries research, during the salmon runs in 1907 and 1908. Although there were no fixed field stations, the first experimental hatchery was built on the Bolshoi Chkhil. The Tsarist Department of Agriculture mounted a Far East Expedition in 1915-1916, focusing primarily on the Amur River.

An Amur Ichthyological Station was created in Khabarovsk at that time, but was destroyed during the Civil War years (Borisov, 1964, 55, 63).

In western Russia, naturalists and wildlife biologists created a Commission on Nature Conservation in 1912, under the auspices of the Imperial Russian Geographic Society, beginning a movement to create a network of preserves (zapovedniki) to conserve Russian flora and fauna. The preserves were envisioned by early proponents as a set of index sites where human activities would be excluded in order to observe and document ecosystem dynamics. Although these early ecologists believed that they could protect closed ecological systems, a notion since disproven, their systems approach was ahead of its time (Weiner, 1988, 15-16). Unfortunately, this multidisciplinary systems approach all but disappeared in Soviet natural resources research. Strict preserves (zapovedniki; no economic activity permitted) and reserves (zakazniki; limited economic activity permitted) were supported by both the pre-revolutionary Tsarist and the Soviet governments. Support was economically based; administrators hoped that reserve set-asides could halt the drastic decline in sables and the corresponding decline in government revenues from Siberia and the Russian Far East (Ustinov, 1997, 5; Anonymous, 1996).

10.2.4 1915-1946

The First World War (1914-1918), the Russian Revolution (1917) and the ensuing Civil War (1918-1922) interrupted plans for further research in the Amur River basin until the mid-1920s. The Russian Far Eastern University initiated salmonid and fisheries research in 1923, by inviting G. U. Lindberg (Russia) to lead their fisheries faculty. University faculty and Dalrybookhota staff began to lobby for fisheries research and development in the region. Their efforts resulted in the establishment of the Pacific Ocean Applied Fisheries Research Institute (TONS, 1924) in Vladivostok, the precursor to the Pacific Fisheries and Oceanographic Research Institute (TINRO-Centre). Under the auspices of the new Institute, salmon researchers began to study Amur and Primorye salmon resources in 1925. In the early days of the Institute, there was regular collaboration between the university and the fledgling applied fisheries science laboratory (Borisov, 1964; Ivankov, 1997). By 1927, seven multi-species research sites had been developed along the mainstem Amur, and fall chum data was also collected in nine tributary basins (Eronova, 1999).

The first national fisheries institute was created in Moscow in 1922, to provide applied scientific research and planning capabilities for Central Fishing Agency (Glavryba) and to supervise regional fisheries science institutions. The organization went through several name changes and reorganizations, becoming VNIRO in 1934 (All-Union Fisheries and Oceanographic Research Institute; Borisov, 1964, 65, 80).

When the management of the fishing industry was transferred to the Provisions Ministry in 1929 with the beginning of collectivization and industrialization, fisheries science was forced to become much more applied and lost much of its earlier ecological and conservation emphasis (Lajus, 1997, 265). For instance, hatchery research was a priority in the Amur River basin. The first Russian hatcheries in the Far East began operating in the Amur basin in the late 1920s and early 1930s. Built on the Bira and Bidzhan rivers, they were designed to restore the failing high value upriver fall chum runs (Eronova, 1999).

As the last region to come under Soviet control, the Far East still had strong regional leaders and a sense of independence. Particularly after the fall of Manchuria to Japan in 1931, Stalin and his security apparatus were worried about national security in the Russian Far East. Stalinist purges in the region destroyed old leadership networks in the name of national security. Academic institutions were a particular target, and multilingual scholars were depicted as traitors and foreign spies. The Far East University and the Far East Branch of the Soviet Academy of Sciences were closed in 1939, after many of the faculty and scholars had been arrested during the Stalinist terror (Stephan, 1994, 203, 223). The Pacific Fisheries and Oceanographic Research Institute was not closed during the purges, but it lost its independence, becoming part of the All-Union Fisheries and Oceanographic Research Institute (VNIRO) in 1933. Fisheries and marine scientists from the University and the Academy went to work for the Pacific Fisheries and Oceanographic Research Institute (TINRO). The Khabarovsk, Kamchatka and Sakhalin branches of the Pacific Fisheries and Oceanographic Research Institute (TINRO) were founded in 1932-33 (TINRO-Centre, 1999; Ivankov, 1997).

The first two Five-Year Plans (1928-32, 1933-37) took into account cyclical variability in Pacific salmon resources for the establishment of plan targets, but in the Third Five Year Plan, targets for the Far East fisheries were set solely on the basis of harvest capacity. Early Russian scholarly attempts to develop mathematical models of optimal fish harvests were discredited by the dominant fisheries scientists, who were intent on maximizing harvests for society (Lajus, 1997).

From 1938-41, a field research study on the Amur was conducted to clarify issues regarding the spawner-recruit relationship for fall chum and the effect of riverine habitat conditions on recruitment. Although not strictly proven, the researchers concluded that there was a clear spawner-recruit relationship, and inferred density dependence, i.e., at high densities fewer recruits survive per spawning adult salmon. Salmon harvest on the Amur River and on the Kamchatka Peninsula were subsequently managed to limit escapement. However, Smirnov (1961, 76-81) believes the quotas were at best ineffective, and at worst harmful, given extremely limited information regarding the actual size of spawning populations. Early research on the Amur salmon run in 1923 corroborates this opinion – Navozov-Lavrov found that quotas were often larger than entire run sizes (Smirnov, 1961, 76-81).

Territorial Fisheries Conservation, Enhancement and Enforcement Agencies (Rybvods) were opened on Kamchatka and Sakhalin in 1946, in the aftermath of WWII. Fisheries on northern Sakhalin and Kamchatka had previously been managed from Amurrybvod (Khabarovsk) and Primorrybvod (Vladivostok).

10.2.5 1947-1975

An Ichthyological Commission was created within the Academy of Sciences (1949) to coordinate fisheries research across the government. The Commission was developed against the backdrop of growing scientific obligations under international treaties, as well as a push for expansion of the domestic fishing industry. The Soviet

Union joined the International Whaling Commission and the International Northwest Atlantic Fishery Commission in 1946 (Mathisen and Bevan, 1968, 22-23, 44). In 1951, the Ichthyological Commission convened a joint conference with the Ministry of Fisheries (Ministerstvo Rybnogo Khoziaistva) on forecasting, fish reproduction and biological productivity. The context was a growing Soviet interest in hydroelectric development, and the desire to maintain and increase fisheries productivity using hatcheries, fish introductions and improved management of wild stocks. From the 1950s through the 1970s, attempts were made to acclimatize Pacific salmon from the Amur River, Sakhalin Island and Kamchatka to various locations throughout the former Soviet Union (Borisov, 1964, 100, 128-130; Savvaitova, 1999).

The Ichthyological Commission Conference began a new research emphasis within TINRO in the Russian Far East, designed to open previously under-utilized marine fisheries to the commercial sector. A TINRO affiliate was opened in Magadan in 1959. Southern Sakhalin and the Kurile Islands had just been reacquired from Japan, and the region provided new ground for the expanding Russian fishing industry. The abundant pink salmon of the Sakhalin-Kurile jurisdiction spawned a new generation of pink salmon research, particularly on migration and homing patterns. The TINRO laboratories also conducted ecological studies on Kamchatka sockeye, and Amur-based research on hatchery techniques and run forecasting (Borisov, 1964, 105-107).

Despite growing contacts with fisheries biologists in other countries, attempts to introduce theories and experience from abroad into Soviet fisheries management was looked upon unfavorably in the 1940s and early 1950s. A few ideas were introduced in translation or in essays by prominent ichthyologists, but were either ignored, or the books were not distributed. In the broader culture, there was an ongoing "battle with cosmopolitanism." Lajus (1997) cites the 1951 Conference on forecasting, fish reproduction and biological productivity as the height of this battle in fisheries science. F. I. Baranov's theories (1918, 1925) that harvest was the major determinant of stock status and arguments for mathematically-based optimum yield harvest targets were roundly criticized. The accepted dogma was that biotic and abiotic environmental factors were the only determinants of stock status, and that harvest was not a factor. Baranov's theories were only accepted in the mid-1960s, almost fifty years after his first publications and many years of overharvest in various Soviet fisheries (Lajus, 1997).

After Stalin's death (1953), academic institutions in the Russian Far East were slowly revived. The Far Eastern State University was reopened in 1956, and immediately began to focus on training fisheries scientists, aquatic and marine biologists for the federal TINRO and Rybvod systems. In late 1966, the precursor to the present Institute of Marine Biology (Far East Russian Branch, Academy of Sciences) was formed, and also sought newly trained scientists (Ivankov, 1997).

The Ichthyological Commission was transferred from the Academy of Sciences to the Ministry of Fisheries in 1962, and mandated to identify new distant water fisheries and to develop better harvest technologies to increase the efficiency of food production (Borisov, 1964, 1). As salmon runs in the Amur River basin continued to decline, they were monitored more intensively than at any time in their history. Twelve Salmon Reproduction and Mitigation Stations worked year round, with staffs of 3-6 people. These Stations were likely collection sites for reproductive material to be used at the two hatcheries in the Amur basin. There were seven Amur River Biological Research and Monitoring Stations, two of which emphasized salmon. Despite the multiplicity of data collection points, the material collected was of poor quality because of the low level of training for field staff (Eronova, 1999). In the early 1970s, salmon harvest monitoring network was downgraded further, with monitoring sites shifted to district-level Fish Inspectorates. Staff size diminished over time from five or so to one person, not always including a fisheries biologist (Eronova, 1999).

In this period, environmental activities were channeled through officially sanctioned organizations such as the Society for Nature Protection (est. 1924) and student nature patrols (druzhiny) founded in the 1960s. The sudent nature patrols supported the system of nature preserves (zapovedniki), assisted in anti-poaching activities, and helped keep track of endangered species. They were a non-confrontational network that helped make the system work. The university-based druzhiny created a network of young researchers committed to environmental issues, and formed the backbone of the emerging Russian environmental movement in the 1980s. Although there was a strong activist bent in the Russian movement during the perestroika (reform) period of the late 1980s and early 1990s, which strongly supported democratic reforms, the activist approach faded as economic realities became increasingly harsh throughout Russia (Garb, 1995, 687-690).

10.2.6 1976-2000

Fisheries research programs in general expanded rapidly in the 1970s, and there were many collaborative efforts between the Far Eastern State University, the Institute of Marine Biology, and the TINRO. Students were often involved in research during this period, as funding was abundant. As funding became scarcer in the 1980s and then virtually disappeared in the 1990s, university research programs were scaled back and become more local in emphasis. After an initial severe contraction of all research organizations in the early 1990s to protect their own turf and budgets, in the late 1990s the three major fisheries and aquatic research organizations in the Russian Far East resumed collaborative programs (Ivankov, 1997).

In the late 1970s, an interdisciplinary program entitled "Losos" (Salmon) was developed to once again elevate the status of salmon as an economic resource. It was to be implemented by TINRO and the Academy of Sciences Institute of Marine Biology (Vladivostok). The intent was to dramatically increase both natural and artificial production of salmon through improved harvest technology, hatchery technology and better forecasting of wild salmon runs. A new Salmon Laboratory was created within TINRO-Centre to investigate early life history stages of chum and pink salmon in order to improve hatchery technology. The program was not fully funded however, and plans for future hatcheries in all regions except Sakhalin remain on the drawing board (Glubokovskii, 1989, 3).

In the mid-1980s, the Ministry of Fisheries confirmed a new program to improve stock forecasts, emphasizing marine surveys of juvenile salmonids and high seas sampling of adult salmon during their return migration. This approach has been particularly successful for predicting pink salmon variability and, given that pink salmon is the most abundant species in Soviet waters, has helped target harvesting and processing effort to the most effective times and locations during the fishing season (Gritsenko, 1994). By the early 1990s, TINRO-Centre was conducting routine research cruises to improve forecasts of pink salmon abundance for the subsequent commercial season (Shuntov and Chigirinskii, 1995).

As attention to the ocean increased, funds for freshwater monitoring, research and enforcement diminished. By the late 1980s, most salmon research in both the TINRO and Rybvod systems was conducted on an expeditionary basis, rather than from fixed field stations and monitoring points. For instance, although there are now fourteen operating Fish Inspectorates within Khabarovsk Territory, most have only two staff members, and the level of fisheries biology training is generally low (Eronova, 1999). The situation on Kamchatka and Sakhalin is better with regard to training and staffing, as the Rybvods in those regions receive income from foreign fisheries within their jurisdictions. Fisheries issues in the latter two territories also receive more political attention territorially and federally, as the fishing sector plays a greater role in the territorial economies of Kamchatka (75%) and Sakhalin (30%). Although fisheries are responsible for an estimated 48% of Primorye's economic activity, the fisheries occupy a different political niche, because the lion's share of the harvest occurs in Kamchatka, Sakhalin and Magadan waters (economic activity estimates from Newell and Wilson, 1996).

With the collapse of the Soviet Union, the Pacific Fisheries and Oceanographic Research Institute (TINRO) network was restructured and the territorial units called for greater autonomy. The Institute dropped "Oceanographic" from its name, and focused even more on applied, rather than basic, research. Under the Soviet system, federal Fisheries Research Institutes in the territories were subservient to TINRO-Centre in Vladivostok. The Sakhalin and Kamchatka Fisheries Research Institutes became independent of Vladivostok in the mid-1990s, and now report directly to Moscow. The Magadan and Khabarovsk Fisheries Research Institutes still report to the Vladivostok-based Pacific Fisheries Research Institute. A small, new TINRO institute was created in Chukotka. The Kamchatka and Sakhalin Institutes wanted to report directly to VNIRO in Moscow in order to make their case directly regarding stock forecasts and potential allocations, in order to minimize access to Primorye's large distant-water fishing fleet (Rassadnikov, 1996).

Russia ratified the PICES Convention (North Pacific Marine Science Convention) in 1994. Russian scientists have become increasingly involved in foreign-funded multilateral research in the 1990s, as budgetary support has become scantier from domestic sources. Various estimates suggest that the federal budget provides at most 25% to 40% of the budget for federal Rybvods and TINRO-system laboratories in the territories of the Russian Far East. The remainder is cobbled together with income from fines, agreements for foreign involvement in test or survey fisheries, and quasi-private fishing companies associated with the federal organizations (Knapp and Johnson, 1995, 17-18, 25).

The Russian Federation, as Japan, lacks a tradition of civic activism. There are few active citizens' groups in the Russian Far East which focus on fisheries issues. The most active groups are based on Kamchatka and Sakhalin, where fisheries are critical to the local economy and sense of place. For the most part, they are not membership organizations, but non-profits created to receive funds from the Russian Federal or Territorial Ecological Funds or from foreign environmental groups and foundations. Many field-level Russian fisheries biologists are strongly conservation-oriented, but lack a means to network and coordinate activities with like-minded colleagues. The pre-Revolutionary Russian Fisheries Society has not been revived, and there is no professional organization for fisheries biologists. Fishermen's newspapers published in each of the territorial units of the Russian Far East, which as the primary means for communication within the fishing community. The Internet is beginning to have an effect on civic activism as well, but is hampered by top-down control of access within many fisheries agencies and research institutes.

Native associations and trade groups are also active on fisheries issues. Regional native associations are just beginning to expand beyond short-term issues of salmon allocation to habitat preservation and fisheries management. Former Soviet-era "trade unions" have become fisheries industry lobby associations, actively working the political system and international aid organizations for funds to develop regional fishing industries.

To date there has been no fisheries conservation or allocation litigation in Russian courts.

10.3 British Columbia

10.3.1 Pre-1870

Canadian fisheries biologists and fish merchants brought with them conceptions based upon Atlantic salmon, *Salmo salar*. Canners and most biologists initially believed that Pacific salmon did not die after spawning, that it was simply an Indian legend. The belief persisted into the 1890s (Healey, 1993).

10.3.2 1870-1896

As early as 1880, British Columbia Inspector of Fisheries A. C. Anderson noted that each river had discrete salmon stocks, the abundance of returning spawners varied from river to river, and there was a relationship between the number of spawners and subsequent recruits (McDonald, 1981, 1658).

Harvests have been recorded by species since the inception of the commercial fishery. They were initially based upon the number of cases of canned salmon packed, or "pack". Although the system likely underestimated actual harvests, because the mismatch between excess of harvesting over processing capacity generated significant waste in good years, it accurately reflected harvest area and run, because of the dispersed location of the processors and fisheries (McDonald, 1981, 1659; Healey, 1993).

Spawning surveys became routine prior to the turn of the century, in order to forecast future runs on the basis of returning spawners. Initially these surveys were completely subjective, lacking a standard method or approach (McDonald, 1981, 1659).

10.3.3 1897-1914

The stock concept became the basis for fisheries management in British Columbia at the turn of the century. Fisheries Commissioner J. P. Babcock advocated the stock-recruitment concept as the basis for management of the Fraser River sockeye fisheries, in order to maximize sustainable harvests. Babcock believed that the conditions on each river needed to be known, in order to set optimal time, area and gear regulations to promote escapement. Pack statistics became an unreliable method of tracking the size of specific salmon runs at the turn of the century. Motorization of the gillnet fleet and the advent of the tendering system made it possible to fish in one area and deliver in another, and commercial trolling intercepted fish during nearshore ocean feeding, before it was clear which river they would return to (McDonald, 1981, 1658-1659).

The fishing industry was integral to the settling of Canada and a vital sector of the economy. As such, the Canadian government believed there was an important role for government-sponsored basic and applied fisheries research to support the industry. Just prior to the turn of the century, the Canadian Parliament created a Board of Management (1898) for fisheries research to sponsor and coordinate applied fisheries research around the country. The Pacific Biological Station at Nanaimo, BC was established ten years later. The initial focus in British Columbia was to provide sufficient information about salmon stocks that they could be managed for optimal escapement: information regarding migration routes, migration timing, abundance, and age at return Just prior to WWI, the Board was upgraded to the Biological Board of Canada (Parsons, 1993, 532-534; McDonald, 1981, 1658).

10.3.4 1915-1946

The late 1920s were a fertile period for salmon research. The new chairman of the Biological Research Board instituted a policy of hiring permanent staff for the research stations, and a series of long-term studies were begun at Nanaimo. Tagging became a basic tool for gathering life history information. The study that had the greatest effect on fisheries management was a comparative study of reproductive success of wild and artificially propagated sockeye. Fifteen government-operated pre-WWI hatcheries were in operation at the time, rearing sockeye salmon. Foerster's Cultus Lake study (1930-31) demonstrated that artificial propagation was no more effective than natural spawning. Based upon these results, all British Columbia hatcheries were closed by 1937 (McDonald, 1981, 1658; Johnstone, 1977).

In the 1920s, fisheries biologists along the eastern Pacific formed the International Pacific Salmon Investigation Federation to coordinate research. Prior to this time, the primary research focus in British Columbia had been on sockeye salmon. A study of the north-south coast-wise movement of coho and chinook along North America was developed by Federation members, but was hampered by the lack of cooperation from US fishermen in data collection. Nanaimo researchers also studied homing in sockeye stocks, and changes in size-age structure of salmon populations over time and space (Johnstone, 1977, 127-128). The Department of Marine and Fisheries created a system of twenty-seven statistical areas for salmon harvest in 1927 in order to manage for escapement by separately opening and closing each small area to fishing (Healey, 1993, 251).

10.3.5 1947-1975

In response to treaty obligations under the US-Canada Salmon Treaty and the International North Pacific Fisheries Convention, the Department of Fisheries was reorganized in 1949-50 in order to implement a fisheries development program including a broad array of applied biological and socioeconomic research. Government funding for salmon management increased substantially, freeing the Department of Fisheries and Oceans somewhat from its role of supporting the canners (Meggs, 1991, 185). Catch statistics began to be routinely collected across statistical areas on the basis of fish sales slips in the 1951. Escapement counts were standardized in index rivers across the province. After the Tripartite Convention entered into force in 1952, the new International North Pacific Fish Commission coordinated the development of a major research program regarding ocean distribution of Pacific salmon, involving many Canadian researchers (McDonald, 1981, 1659; Healey, 1993, 250).

The new research and monitoring capabilities of the Department of Fisheries allowed it to refine its program of escapement-based management, emphasizing adequate escapement prior to allocating the perceived harvestable surplus among fishers. The approach was grounded in stock-recruitment theory, asserting that a surplus of spawners in a given run was detrimental to recruitment, as previously established redds would be disturbed by subsequent spawners. Resource economists gained prominence in this period, represented in Canada by H. Scott Gordon. In 1954, the Fisheries Research Board published Gordon's report arguing for economic optimization of the fisheries, as part of the post-war effort to modernize Canada's economy (McMullan, 1987b, 119).

The Sinclair Commission was empaneled in 1959 to determine how to apply Gordon's economic rationale to the salmon and halibut fisheries. "Optimum yield" became the major principle for fisheries management. But in order to maximize income, clear property rights needed to be assigned. The Davis Plan for license limitation was the compromise outcome of this new philosophy (Newell, 1993, 128-129).

Research regarding artificial propagation resumed after WWII, in association with efforts to restore sockeye populations in the Fraser River system in accord with US-Canada Salmon Treaty. Artificial stream channels were developed for spawning, with the intent to increase egg to fry survival. The Babine Lake project increased sockeye harvests dramatically in the early 1970s, and helped to revive the federal hatchery program later in the decade (Healey, 1993, 255).

The Fisheries Research Board of Canada lost its independent status in the early 1970s, and became an advisory body to the new Department of the Environment, with its research coordination functions subsumed in the Fisheries and Marine Service (Parsons, 1993, 540-541).

10.3.6 1976-2000

Popular pressure from the fishing industry (harvesters and processors) during the 1970s and 1980s led to the Salmon Enhancement Program, and additional hatchery-focused research. A citizens' Salmon Enhancement Task Group was empaneled to help guide the new program. Harvesters initially demanded habitat restoration funds as well as hatcheries, but the secondary goal of building facilities to provide rural employment led to an emphasis on facility construction (Meggs, 1991, 215-216).

Non-governmental organizations became increasingly involved in salmon management during the 1980s and 1990s. The UFAWU created the T. Buck Suzuki Foundation in 1981, to educate its members and the general public about the importance of fish habitat. Other organizations actively monitoring British Columbia policies regarding habitat, hatcheries, salmon farms and wild fish include the David Suzuki Foundation, the Georgia Strait Alliance, Greenpeace, the Sierra Legal Defense Fund, and the Steelhead Society of British Columbia. Some of these organizations joined with organizations representing Canadian First Nations, academic, and community groups to establish the Pacific Salmon Alliance in 1996. The Alliance's goal is to unite diverse user groups to provide a counterbalance to Department of Fisheries and Oceans top-down fisheries management (Pacific Salmon Alliance, 1999).

10.4/5 Alaska and American Northwest

10.4/5.1 Pre-1870

US ichthyologist J. Richardson rediscovered the Pacific salmon in 1836, almost seventy years after they were first described by Georg Steller on Kamchatka. He assigned them to the familiar genus *Salmo*, and gave them names based on North American colloquial names for salmon and his own preferences. For many years, there was confusion regarding the classification of the Pacific salmon and trout, and a profusion of overlapping names. Pacific salmon were not classified as *Oncorhynchus* until 1866, and the profusion of names was not sorted out until 1883. Pacific trouts remained in the genus *Salmo*, based primarily on a difference in the number of anal fin rays in Pacific salmon vs. Pacific trout (Stearley and Smith, 1993, 4).

10.4/5.2 1870-1896

The US Commission of Fish and Fisheries had a strong bias toward fish culture from its beginnings in 1872. The first appointees were fish culturists, who believed that salmonid survival could be greatly improved in the hatchery setting. In fact, they believed that enough salmon could be produced artificially to render fisheries management unnecessary. Very little was known about salmon biology at the time, and many ill-fated egg transfers were made between basins, because culturists did not understand salmon homing. In a report regarding favorable hatchery sites in the Columbia River, Stone (1885) suggested that salmon returned to whichever streams provided the strongest stream velocity during their return migration (Cone and Ridlington, 1996, 46).

The McCloud River hatchery, established by the Fish Commission's Livingstone Stone in 1872, was a major donor site for chinook salmon eggs. Pacific Northwest interbasin egg transfers began shortly after the hatchery's establishment, beginning a long-standing practice of ignoring local salmonid adaptation in favor of meeting quotas for egg take and fry releases. Chinook eggs and juveniles were shipped to several eastern states and to Australia, Argentina and Germany, among other countries (Lichatowich, 1999, 125; Helle, 1981, 1666).

In 1891, ichthyologist David Starr Jordan became the founding president of Stanford University, and took his colleague Charles Gilbert with him to chair the zoology department. Gilbert focused his research program on Pacific salmon, fathering contemporary fisheries biology in the United States. The only phases of the salmon life cycle that were easily observable were the upstream migration and spawning, thus they were central to early salmon studies (Lichatowich, 1999, 162).

The American Fish Culturists' Society broadened its purview in 1884, becoming the American Fisheries Society.

10.4/5.3 1897-1914

Gilbert pioneered the use of scale reading to discern the life histories of Pacific salmon. As early as 1914, he published studies regarding the fidelity of chinook salmon to home streams, on the basis of research in British Columbia. Fish culturists were uncomfortable with the notion of home streams and distinct populations, because it would change the common practice of interbasin transfers. Harvest managers preferred to treat species as homogenous populations in order to manage each as a unit, rather than treating seasonal races as distinct populations. Fishery managers in this period were able to sustain this myth, through a belief that Pacific salmon migrated no more than 35-55 km offshore and returned to natal streams through random chance (Lichatowich, 1999, 162-164).

10.4/5.4 1915-1946

Clearly evident salmon declines throughout the contiguous United States and in Alaska generated a demand for better fisheries science. By the 1920s, the center of Pacific salmon research had shifted to Canada's Fisheries Research Board laboratory at Nanaimo, and to the new School of Fisheries at the University of Washington (1919). The Washington legislature created a Department of Fisheries and a Fisheries Board, designed to conduct fisheries research. The Board's policy of increasing escapement over funding new hatcheries was unpopular, however, and the Board resigned en masse in 1927 over allocation issues in northern Puget Sound (Crutchfield and Pontecorvo, 1969, 132-136).

The White Act (1924) mandate for salmon escapement in Alaska was the first move in the United States toward biologically-based salmon management. The novel approach was based upon a report by Charles Gilbert and US Fish Commissioner O'Malley about the state of the Alaska fishery. Secretary of Commerce Herbert Hoover, one of Gilbert's former zoology students, helped to craft the compromise

Alaska fisheries legislation. Its fixed 50% escapement rate, though perhaps not the best solution for all salmon populations at all times, was a good start protecting the future reproductive potential of salmon runs. However, the research and monitoring required to implement the policy were never fully developed, as conflicting pressures among vested interests led to partisan sniping and congressional neglect of research funding for the Bureau of Fisheries after the passage of the Act (Crutchfield and Pontecorvo, 1969, 96-97; Lichatowich, 1999, 162).

One of the most notable US salmon researchers during this period was Willis Rich, a student and subsequent colleague of Gilbert's at Stanford University. In 1939, Rich published a paper supporting the theory of distinct local salmon populations using an array of physical and biological field data. Rich argued that conservation needed to be based on local populations. At the time, Rich's theory went unheeded in the United States, as most fishery managers wanted to believe that hatcheries and interbasin fish transfers would successfully mitigate for river development, habitat damage, and overharvest (Cone and Ridlington, 1996, 33-36).

Canadian researchers had published the results of chinook tagging studies demonstrating that Columbia River chinook migrated at least as far as Vancouver Island, eliminating the "random chance" argument in 1937. Although the home stream theory generally became accepted, fisheries management practices did not change. In the economic context of the Great Depression and then the energy demands associated with WWII, public works projects and hydroelectric development were very compelling to Congress. Congress members perceived salmon to be less important, and put their faith in hatchery production of salmon to mitigate for river development (Taylor, 1998a, 54).

During the late 1920s and early 1930s, trained fisheries biologists were just beginning to emerge from universities such as Stanford and the University of Washington. Early graduates were not trusted by fish culturists working for state fisheries boards, because of the graduates' broader perspective on fisheries and the environment. Gilbert protégé W. F. Thompson became the director of the University of Washington School of Fisheries in 1929, and discarded canning technology classes in favor of chemistry and mathematics, deepening the division between fisheries scientists and managers. Although the Oregon Fish Commission founded its Research Division in 1938, it consisted of only one person – Willis Rich, out of a total staff of 271 people. Hatcheries accounted for 84% of the budget, and science for only 2% (Lichatowich, 1999, 158-161; Taylor, 1998b, 98).

One of the elements of the growing Columbia River fisheries and water management bureaucracy in the late 1930s was the development of the Fisheries Engineering Research Program with a laboratory at Bonneville Dam. The Bureau of Reclamation and the Fish and Wildlife Service also participated in the research program, which was developed to formalize research regarding fish passage and mortality in the hydropower system. The new federal lab drew staff from a similar research group already in existence at the University of Washington, and competed with the university researchers for funding in the 1950-60s. The initial focus of the program was adult fish passage, but after tagging studies by the Fish and Wildlife Service reported 15% juvenile mortality at Bonneville Dam, juvenile fish passage became the major research issue. The Corps of Engineers and the FWS were reluctant to release the study, because of its implications. Future studies confirmed that 15% juvenile mortality per major dam was a reasonable conservative estimate of mortality (Mighetto and Ebel, 1994).

Bonneville Dam (1938) in the Columbia River basin facilitated actual salmon passage counts for upstream salmon runs starting in 1938 (e.g. Beiningen, 1976, E12). As further dams were built, escapement could be estimated by subtracting known in-river harvests from the appropriate dam count. Spawning surveys could be used to calibrate escapement estimates. However, spawning surveys were not conducted systematically prior to the 1970s, and therefore are unreliable for the interpretation of escapement trends at a subbasin scale (Beiningen, 1976, E12-13).

10.4/5.5 1947-1975

Canners operating in Alaskan waters became increasingly concerned about harvest declines, and in 1940 they created the Alaska Salmon Industry, Inc., which taxed the industry to create and fund the Fisheries Research Institute (FRI) at the University of Washington. The Institute began its first field season in 1946, after the conclusion of WWII. Although the funding mechanism had to be altered because of anti-trust issues, industry financing of salmon research at FRI continues to this day. The first mandate to FRI was to study the dynamics of Bristol Bay sockeye salmon runs (Stickney, 1989). Researchers concluded that the decline was because of "natural factors", a conclusion now supported by fisheries-climate variability research. At the time, the results eased the conscience of canners regarding conservation, and the canning industry gained valuable academic allies (Cooley, 1963).

The FRI researchers were the first in the United States to state that separate escapement goals would be required for each river system, in order to maintain run productivity. The Institute's program was the first long-term, multi-faceted salmon research study (1946-present) to survey and monitor spawning grounds, investigate sockeye life history, and study gear selectivity. The premise of the program was that only accurate run-size forecasts required long-term data regarding harvest, available spawning area and annual escapement. Until the 1950s, escapement data had been collected inconsistently, and was not useful for predictive analyses. FRI grew in budget and size under its first director, Dr. W. F. Thompson. Sockeye life history studies were expanded to include tagging to track high seas migrations and studies of population structure. Because of declines in industry profitability, in the 1950s an increasing proportion of FRI funding came from the federal government (Saltonstall-Kennedy program) and competitive grants programs (Stickney, 1989). Alaskan harvest declines heightened the sensitivity of Congress to the need for salmon research, and dedicated federal funding increased 9-fold between 1948 and 1959 (Crutchfield and Pontecorvo, 1969, 102).

After the creation of the International North Pacific Fisheries Commission (INPFC), the FRI was commissioned to assist in the determination of the continent of origin of sockeye harvested by Japan on the high seas (Stickney, 1989). The INPFC helped bring a new a new sphere of research into existence, the investigation of marine rearing and migration life stages of anadromous salmon. This research was made possible by the existence of the Japanese high seas fisheries, providing platforms of opportunity for biological studies.

Two seminal works published during this period were Ricker's (1954*) Stock and recruitment* and Beverton and Holt's (1957) *On the dynamics of exploited fish populations*. These papers introduced mathematically-based fishery management to Western fisheries biologists, and quickly became the basis for most salmon management in the North Pacific. The new models assumed a stable stock-recruit relationship, freshwater life stage density dependence, and a harvestable surplus desirable to maintain optimum salmon production (National Research Council, 1996, 276-281).

Biologists at the newly created Alaska Department of Fish and Game together with FRI scientists and colleagues from the US FWS established an escapement-based management system for Alaska's salmon fisheries beginning in 1960. Escapement goals were established as ranges for each management unit, consisting of several populations of a given species from a given area. Goals are regularly reviewed and revised by the Fisheries Board. Escapement is monitored in-season, using aerial surveys, weirs, and counting towers. Regional biologists have the authority to open and close seasons, based on escapement data, and schedules are disseminated to the fishing fleet by radio (Stickney, 1989; Geiger, 1999).

Escapement-based management began in the Columbia River with escapement targets for upriver runs in 1963. Previously, Washington and Oregon harvested fixed percentages of each run, and reduced harvests based upon in-season catch data if perceived necessary. Escapement goals are based on Ricker stock recruitment models, which imply density dependent production in freshwater and a harvestable surplus. Lavier (1976) criticized this approach, arguing that a certain level of carcass deposition was necessary to ensure stream productivity. He also argued that redd disturbance by later, "surplus" spawners was not a valid basis for harvest, because the emergence of both early and late fry was an important risk-spreading function in the natural reproduction system. Both of these arguments would have implied reductions in harvest quota, and neither was accepted at the time (Lavier, 1976, H6-16).

Several scientific advances came into play beginning in the 1970s, with varying ramifications. Genetic research and salmon tagging data substantiated the existence of stream-specific salmon stocks. The US Bureau of Commercial Fisheries hosted a stock identification workshop in 1970, at which Ricker first presented his seminal review on salmon stocks, published two years later (Ricker, 1972). A lively debate ensued about the appropriate units for harvest and hatchery management, persisting to the present.

10.4/5.6 1976-2000

The first effort to list salmon under the Endangered Species Act (1973) was a petition to list several Columbia River populations in the late 1970s. NMFS and the FWS suspended the mandated status reviews, because they felt that the new Northwest Power Planning Council's Fish and Wildlife Program would ameliorate many of the concerns regarding declining salmon populations through improvements in "flow shaping" (controlling seasonal river discharge) by the Federal Columbia River Hydropower System. Although the new program had planning authority for the entire salmonid life cycle, it had no implementation authority. In 1986, the Council published assessments indicating that pre-European salmon abundance in the Columbia River basin ranged from 11-16 million fish, and set run restoration targets at 8-11 million fish. Although NPPC plans allocated funds for increased hatcheries, habitat restoration and amelioration of hydroelectric system effects, hatchery and harvest practices did not change to reflect wild stock-based management until the first Endangered Species listings occurred in the Columbia basin in the 1990s (National Research Council, 1996, 136-137; Lichatowich, 1999, 168).

The founders of the Alaska hatchery system took stock structure explicitly into account, building genetic protocols and injunctions against interbasin transfers into the system from its beginnings in the late 1970s. Alaska fisheries managers had the advantage of emerging literature regarding wild-hatchery fish interactions and hatchery experience accrued in the American Northwest. Alaskan hatchery and harvest policies have been revised upon the basis of new studies, with the addition of disease control and wild salmon escapement policies in the late 1980s and early 1990s (McGee, 1995).

New genetic analysis techniques generated new studies beginning in the early 1980s regarding the effects of hatcheries and harvest on salmon, and the population structure of salmon and trout in specific geographic locations (Chilcote et al., 1986).

The second effort to list a salmon stock occurred in 1985, when the American Fisheries Society petitioned the NMFS to list winter-run chinook in the Sacramento River. NMFS declined to list the winter-run chinook population in 1987. As the population continued to decline, the NMFS responded with an emergency listing as a threatened species in 1989. Winter-run chinook was listed as endangered in 1994. The initial process to list the winter-run Sacramento chinook was complicated by the fact that there was no science or policy for determining the appropriate salmonid unit that represents a "distinct population segment" under the Endangered Species Act. Subsequent listings by the NMFS were based on "evolutionarily significant units" (ESUs). ESUs are populations or groups of salmonid populations that are: 1) substantially reproductively isolated from other populations, and 2) contribute substantially to the ecological or genetic diversity of the biological species (Waples, 1991).

In the late 1980s, it was unclear whether the National Marine Fisheries Service (NMFS) would respond to salmon listing petitions one by one, or conduct a systematic review of salmon stocks and preemptively list them under the Endangered Species Act. Members of the Oregon Chapter of the American Fisheries Society chose to act independently, conducting a review of stock status in Washington, Oregon and the Columbia River basin based upon the best available information (Nehlsen et al., 1991). The resulting publication, *Salmon at the Crossroads* (1991), was a turning point in salmon debates – it became abundantly clear to the public as well as the scientific community that we were losing entire populations of salmon, with dire consequences for the fisheries and watershed ecosystems. NMFS subsequently decided to review the status of stocks by species and area, on the basis of "evolutionarily significant units", or ESUs.[31]

Several environmental groups became involved in salmon issues after the formation of the Northwest Power Planning Council (1980) in the Columbia River basin [see \NPPC Directory of Organizations]. After the publication of *Crossroads*, many more citizens' groups became involved in salmon issues, particularly in habitat restoration efforts funded by the states. Conservation organizations, the Oregon Chapter of the American Fisheries Society and tribal organizations collaborated to petition for salmon listings under the Endangered Species Act (ESA), and to litigate against federal agencies for neglect of responsibilities under the ESA and the National Environmental Policy Act.

The listing of Snake River (Columbia basin) sockeye (1990) and chinook salmon (1992) triggered a requirement that all federal agencies whose actions might affect the threatened or endangered population must first consult with the National Marine Fisheries Service. Other implications of the listings were the requirement for "weak stock" management of harvests, including incidental catches in other fisheries, and a reevaluation of hatchery programs for their effect on listed natural populations. In the Columbia River Basin, the ESA required the NMFS to review the adequacy of the hydroelectric operators' flow shaping and the COE's policy of barging juvenile salmon downriver to reduce mortality, under the "incidental take" provisions of the Act (National Research Council, 1996, 137-138).

State fisheries agencies in the Pacific Northwest have a great deal of leverage in harvest management, both within the Pacific Fishery Management Council and in state waters. They monitor the fisheries and collect escapement data, develop stock assessments and the forecasting algorithms that all subsequent allocation negotiations are based upon. Simple stock-recruitment models have been recognized as too simple to be reliable, because of the lack of consideration of mixed population fisheries,

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[31] As of 1999, twenty four salmonid ESUs had been listed in Washington, Oregon and Idaho. Nine other ESUs are candidates for listing, pending further review (National Oceanic and Atmospheric Administration, 1999).

interspecies interactions and environmental variability. The subfield of salmon biometrics evolved to produce new and theoretically more robust modeling and forecasting techniques. The new models are very complex and data intensive, and rely on high-powered computers. The model-based approach has the effect of distancing harvesters from decision-making processes (Rutter, 1997; National Research Council, 1996, 284).

CHAPTER 11 SUMMARY AND CONCLUSIONS

North Pacific jurisdictions appear to be following a similar trend in salmon fishery management, initially emphasizing production, occasionally emphasizing community preservation and lastly embracing biodiversity conservation. Overall, the modern North Pacific jurisdictions appear to be attempting to recreate a holistic approach to salmon management characteristic of native pre-colonization societies using the institutions available in today's more diverse and populous ones.

In pre-colonization societies, salmon management was family- or kin-group based, and spatially specific. Salmon was a mainstay of coastal and interior riparian subsistence cultures. Salmon harvest was a critical piece of the annual work calendar, in societies where work was performed by family groups and embedded in ceremony and community beliefs about the environment. Production, community preservation and biodiversity conservation were inseparable goals, as the fisheries were practiced. A certain level of production was both necessary and feasible given family size, in order to sustain the family and community. Biodiversity conservation (i.e., harvest which maintained species and life history diversity) was an outcome of salmon sharing up- and down-stream with other native villages, related by blood, marriage ties or other agreements.

Modern technological societies have disrupted the intimate cultural ties to nature. We have many substitute foods and countless means of earning a cash-based income. Given the diversity and numbers of harvesters and the market value of salmon, the contemporary jurisdictions have had to develop an array of management institutions to control fishing.

11.1 How have harvest trends affected harvest management and salmon management philosophies?

Three major responses to salmon harvest trends are apparent in the five North Pacific jurisdictions. These are (1) investment and disinvestment in hatcheries; (2) redirection of fisheries to new fishing grounds, and (3) regulatory responses.

11.1.1 Hatcheries

Declining harvest trends often triggered investment in hatcheries, particularly during times of economic prosperity, while steady or rising salmon production was associated with the disinvestment in hatchery programs, especially during economic downturns. In Alaska, the federal government operated a handful of hatcheries, but they were closed down during the Great Depression because wild salmon fisheries were highly productive. British Columbia began to experiment with hatcheries in earnest after the Hell's Gate rock slide obstructed sockeye spawning and rearing grounds in 1913. However, given the low productivity of hatchery technology at the time, combined with steady wild salmon production, Canada closed down the federal hatchery system during the Great Depression. The Soviet Union built its only two pre-WWII hatcheries just prior to the Great Depression, in an attempt to arrest the decline of the valuable Amur River fall chum run. The construction of new hatcheries was then put on hold as pink salmon were abundant, and chum harvests relatively steady.

Hatchery policy in Japan was more complex, due to the dual goal of producing biomass and sustaining coastal fishing communities. The government of Japan acquired several failing private salmon hatcheries during the Depression years, and closed many of them because both coastal and distant water harvests were on the rise in the 1930s. The coastal component on the rise was primarily Russian-origin pink and cherry salmon. Given the poor contribution of Japan's wild chum runs to the coastal fishery, government and private investment in hatchery programs continued at a low level.

Chinook salmon, the premier American Northwest species in both market value and abundance, peaked by 1883 and declined precipitously. Hatchery production began prior to the decline in the 1870s and was viewed as a technical solution to the otherwise intractable issue of salmon harvest allocation. Although hatchery construction in the American Northwest slowed during the 1920s and 1930s, federal and state investment in hatcheries grew rapidly by the end of the Great

Depression due to the inception of the federal hydropower system on the Columbia River. The federal-state hatchery system continued to grow through the 1970s.

Both Alaska and British Columbia reinvested heavily in hatchery systems in the late 1970s and early 1980s, primarily because of low harvests of their premium target, sockeye salmon. Hatcheries were also expanded for pink salmon in Alaska in the 1970s, after a record low harvest in 1967. Although the Soviet Union launched a major hatchery initiative in the early 1980s, few hatcheries were built because federal funds were never fully appropriated for the program. Pink and chum harvests, predominant in Russia's catch, increased and then declined again in the early 1980s, stirring renewed concern among fishery managers. Since the collapse of the Soviet Union, there has been a surge of new hatchery construction and renovations on Sakhalin Island, and to a lesser degree in the remaining regions of the Russian Far East. Japanese investment and technology has been instrumental in the hatchery renewal process, because in Russia, producing fish provides access to salmon quotas. In Japan, federal investment in the hatchery system increased in the 1970s, because access to traditional distant-water fishing grounds diminished and total Japanese salmon harvests declined.

Hatcheries may have been perceived as more effective, and therefore preserved, because of the temporal coincidence of improved hatchery technology and favorable ocean rearing conditions. Climate cycles became favorable to northern pink, sockeye, and chum production as the new hatcheries in Japan, Russia, Alaska and British Columbia came on line in the 1970s and 1980s. Canada also invested in coho and chinook hatchery capacity in the 1970s, though less successfully as marine survival conditions for Canadian-origin coho and chinook have been poor recently. Hatchery rearing technology improved in the American Northwest during a period of favorable coho and chinook survival in the 1960s. After a period of successful hatchery production of coho from the mid-1960s to the late 1970s, returns dropped dramatically when ocean conditions changed.

In the 1990s, Japan and Alaska have gone through yet a further phase in hatchery production. Due to budgetary concerns (declining oil production in Alaska, general economic woes in Japan), both jurisdictions have already or are in the process of disinvesting in government-owned hatcheries while salmon returns are still strong. Hatcheries in both systems continue to be government-subsidized, but are owned and operated by fishery cooperative associations, non-profits or, in Japan, for-profit corporations. Russia is also experimenting with private hatchery ownership. State- and federally-funded Pacific Northwest hatchery programs are now shrinking rapidly for the first time in their history, though due to a new emphasis on natural reproduction and wild stocks, rather than tight budgets.

11.1.2 Spatial redirection of investments.

Perceived declines in salmon harvests frequently led to extensive expansion to new fishing areas and new species. When Japanese stocks first declined prior to the 1900s, Russia's fishing industry was poorly developed and Japanese companies seized the opportunity to fish Russian stocks. Distant-water fishing, both within Russian waters and outside them, became the major component of Japanese salmon production by WWI. Just prior to WWI, Japanese shore-based harvesters increased their harvests of Russian-origin pink and cherry salmon in the Japan Sea and the Sea of Okhotsk. New international harvest agreements formalized Japanese access to high seas fisheries in the 1950s, then curtailed access after jurisdictions were extended in the late 1970s. The only remaining distant-water salmon fisheries today are conducted within the Russian fisheries zone.

As harvests of all species declined in Russia in the 1950s, the central government consolidated collectives and fishing enterprises. Budget resources were allocated toward the construction of distant-water vessels to target fish other than salmon. Many small-scale coastal collectives and enterprises were redirected to harvest coastal marine fishes. The primary fisheries management objective was economic -- to provide as much protein food as possible for the populace.

In Canada, the salmon industry expanded northward to include additional species and fishing areas, beginning in 1880s in search of large new concentrations of sockeye, and continuing later to locate commercial-scale aggregations of any Pacific salmon species. In contrast to Japan, the new areas were within national borders, in the central and northern regions of British Columbia. Due to British Columbia's geographic position between Alaska and the American Northwest and the migratory pathways of Pacific salmon, spatial expansion inevitably led to interception of US-origin salmon.

The fishing industry in the United States also sought new fishing grounds as stocks declined as early as the 1860s. After the prime chinook stocks declined on the Sacramento in the 1860s, salmon investment shifted to the Columbia River. Once the high-valued spring and summer chinook peaked in the 1880s on the Columbia River, many canners invested in fisheries on the Puget Sound and in Alaska. In the American Northwest, spring/summer chinook was displaced primarily by fall chinook and coho salmon production. In the Puget Sound, sockeye salmon was the initial high-value target, gradually supplemented with other species, most notably pink salmon. Both the sockeye and pink salmon runs harvested in Puget Sound were primarily Canadian in origin, and the fortunes of the Puget Sound fishery thereafter varied with natural events such as the Hell's Gate rock slides, as well as state and international politics.

11.1.3 Regulatory and bureaucratic responses

The initial impetus for establishing salmon management bureaucracies varied across jurisdictions, and the management approach varied dramatically between Japan and all the other jurisdictions. Salmon management in Japan is rights-based, whereas in the other jurisdictions it is based upon command and control approaches to governing fishing seasons, areas, gear, and harvest access.

Japan created a national Bureau of Fisheries and promulgated its first national fisheries law between 1885 and 1901. The impetus was the need to clarify harvest rights during the transition from feudal to private ownership after the Meiji Restoration (1868). Market forces led to overharvest of wild Japanese chum salmon runs, the principal target of the commercial fisheries. Nationalization of Japanese rivers, including a harvest prohibition on mature salmon, effectively eliminated native Ainu rights. Commercial fishing rights became the focus of future fisheries legislation. The primary national government role has been to approve a series of amendments of the Meiji Fisheries Law clarifying the rights and responsibilities of Fishery Cooperative Associations and private companies, as well as spelling out license requirements. The Japanese government has also provided an array of subsidy programs for the salmon fishing industry.

Russian fisheries management is based upon command and control; during the Soviet era central control was absolute. The first comprehensive fisheries legislation in Russia was the decree "On the Conservation of fishery resources" (1958), developed in the context of severe declines in Russian Far Eastern salmon fisheries. Prior to 1958, authorities in Moscow issued various decrees regarding the structure of fisheries management. The 1958 decree remains the basic fisheries law in the Russian Federation today. Implementing regulations prohibited individuals from harvesting salmon and created a minimum salmon allocation system for native peoples. Environmental measures were promulgated during the 1970s to protect salmon habitat from the effects of logging and water development, but enforcement has been uneven.

Comprehensive fisheries legislation was already in place when the Province of British Columbia was created in 1870. The impetus behind Canadian legislation was the decline of various Atlantic fish stocks, including Atlantic salmon. The Fisheries Act (1868) gave the federal government the authority to license and manage fish harvests outside of freshwater, and a mandate to conserve fisheries. The first major decline in British Columbia's salmon fisheries was attributable to rock slides in the Fraser River basin. The federal government responded by limiting the native fisheries, creating a food only (subsistence) fishery with area limitations and a permit requirement. The principal approach to Canadian fisheries regulation has been the use of time and area closures, supplemented since 1968 by access limitations. Lastly, Canada pursued negotiations with the United States to reduce interception harvests on the Fraser River sockeye runs.

Passage of the White Act (1924) provided Alaska with its first comprehensive fisheries legislation. The Act was spurred by a softening of international demand for salmon after WWI, and canners' desires for property rights in the fisheries. The compromise legislation created a command and control framework for federal fisheries management in Alaska and mandated that management be based upon escapement. After statehood, the Alaska Department of Fish and Game assumed responsibility for salmon management. In-season management decisions are made at the District level, and policy decisions by the Fisheries Board in Juneau.

The US Fish Commission in 1870 to stem the decline of Atlantic salmon by developing fish culture and Pacific salmon acclimatization programs. The American Northwest states created fish commissions from the late 1870s through the 1890s in response to early declines in chinook abundance. The commissions were charged with fisheries enforcement and hatchery programs, but they had little staff or authority. Closed periods and gear regulations were imposed to reduce effort before the turn of the century. However, they were poorly enforced, partly because of inconsistent regulations among the states in shared areas such as the Columbia River. Heavy fishing pressure and further stock declines during WWI spurred the creation of the bi-state Columbia River Compact, after a threat from President Theodore Roosevelt that he would consider taking federal control over the fishery. The establishment of the Columbia River Compact began a trend toward the creation of new organizations for each new problem. Pacific Northwest fisheries now face a patchwork of authorities including: the Columbia River Compact; fisheries agencies and commissions in Washington, Oregon, California and Idaho; the Pacific Fishery Management Council (1977); the Northwest Power Planning Council; the National Marine Fisheries Service (Endangered Species Act review); judicially imposed management plans, and the Pacific Salmon Commission.

11.2 How has climate variability affected harvest trends and salmon management philosophies?

Climate variability has clearly affected the biomass of salmon harvested at the North Pacific over the past century (Beamish and Bouillon, 1993). It has also strongly affected harvest trends in the individual jurisdictions. Russian, Japanese and Alaskan harvests were clearly high prior to the mid-1940s, declining to a low in the late 1950s and early 1960s, rising to record high levels in the early 1990s. Harvest patterns in the Pacific Northwest were on an opposite cycle. British Columbia's harvests do not show as strong a correlation to climate cycles, due both to catch composition by species and to geographic location (Hare et al., 1999).

In retrospect, it appears that management decisions to eliminate gear groups and augment hatchery programs were frequently made during episodes of poor ocean survival (Taylor, 1998a). As late as the 1970s, managers were unaware of the effects of large-scale climate variability upon salmon survival. Present knowledge and beliefs regarding climate cycle influences on Pacific salmon and steelhead abundance appear to be affecting jurisdictional salmon management philosophies in various ways. It is unclear from the Japanese literature available in translation how knowledge and beliefs about climate cycles are affecting Japanese salmon management practices and philosophies.

Knowledge regarding climate cycles has influenced Russian salmon management philosophies since the 1980s. Russian scientists with the Pacific Fisheries Research Institute (TINRO) network believe that ocean survival is the major determinant of salmon population abundance, overriding harvest as a factor (Radchenko, 1998). The best summation of the Russian philosophy is to base annual harvest quotas on the best available information about marine survival by species (particularly pink salmon) and to harvest as much salmon as possible in years of abundance (Radchenko and Rassadnikov, 1997).

Understanding of climate cycles does not seem to have modified Alaska's salmon management philosophy at present, given large salmon harvests across species and areas (with the exception of the greater Yukon-Kuskokwim delta).

Wariness about the potential effects of cyclical climate variability and global warming appear to have increased the precautionary approach currently taken in British Columbia. Wild salmon and steelhead escapement goals now take priority over biomass production. Dr. David Welch, Canada Department of Fisheries and Oceans, is a frequent spokesperson regarding the potential for global warming to shift the range of Pacific salmon and steelhead northward (Pynn, 2000). Dr. Welch argues that it is a logical precaution to preserve as many elements of existing salmonid genetic diversity as possible, to best preserve the adaptive potential of wild salmon stocks in the face of potential significant changes in their biotic and abiotic marine and freshwater habitat (Welch, 1999).

US beliefs about potential climate variability have factored into the debate about the role of hatcheries. Some argue that hatchery releases should be moderated when marine survival conditions are poor, to minimize the competition between hatchery and wild fish for limited prey resources, maximize the survival of wild salmon, and minimize public expenditures.

11.3 How does the species composition of each jurisdiction's salmon portfolio affect harvest trends and salmon management philosophies?

11.3.1 Original endowment of salmon species

Overall, British Columbia and Pacific Northwest salmon runs are more vulnerable to anthropogenic habitat alteration than those in Japan, Russia and Alaska. Chinook, coho and steelhead play a larger role (proportion of total value and volume of landings) in salmon harvests in the Pacific Northwest and British Columbia than they do in Alaska, Russia, or Japan. Coho, chinook and steelhead are relatively more vulnerable to habitat alteration than pink and chum salmon, the two most abundant species in Russia, Alaska and Japan. The geographic location of the Pacific Northwest is a confounding variable. Human population densities are highest in the southern latitudes i.e., in the Pacific Northwest and Japan, thus habitat alteration has been most significant in these two jurisdictions. Japan still has abundant chum stocks relative to the Pacific Northwest's depressed coho and chinook stocks in part because of the relative ease with which chum salmon are cultured.

11.3.2 Anthropogenic changes in endowment

Anthropogenic factors have simplified Pacific salmon and steelhead diversity across the North Pacific at the life history level. Entire species have not become extinct in any jurisdiction, although non-commercial salmonids such as Sakhalin taimen *Hucho perryi* are on the brink of extinction in Japan. The range of most species has been reduced in parts of all of the jurisdictions, eliminating elements of life history and genetic diversity. Causal factors include pressures of selective harvest, habitat alteration, and hatchery practices, and climate-induced natural variability.

The term "life history simplification" is used here to refer to (1) demographic simplification; (2) loss of seasonal races, and (3) loss of genetic diversity. These three aspects of life history are frequently confounded with one another. Altukhov's research demonstrates that selective harvest of larger sockeye alters not only demographics, but genetic diversity within a sockeye population (Altukhov, 1994, 9).

Russian and Alaskan salmon populations have been the least affected to date, because of low human population densities and largely unaltered salmon habitat. Alaska has likely simplified the genetic diversity and life history diversity of some populations through selective harvest and through the superimposition of hatchery stocks on wild stocks [e.g., pink salmon in Prince William Sound; \Geiger, 1999 #1248]. Some of Russia's salmon populations have also been simplified by fishing practices, e.g., Amur River fall chum, Lake Azabachye sockeye on Kamchatka (Altukhov, 1994, 9). Average weight of fall chum has decreased substantially since Soldatov's original research on the Amur at the beginning of the 20th century. The early fall run fish were primarily from the upriver populations, and were most sought after because they were largest and of superior flesh quality when they entered the river. The head of the seasonal run was fished preferentially for most of the century, and despite current management efforts, still receives the majority of the illegal harvest pressure.

While present Russian hatchery operation policies are stringent, it is probable that many wild salmon populations have been affected by past hatchery practices. Although counter to current biological guidelines, hatcheries still routinely make interbasin egg transfers in order to achieve fry release targets. The majority of Russia's hatcheries are concentrated on Sakhalin Island. Sakhalin has been heavily logged over the last century, and has the second highest population density in the

Russian Far East, after Primorsky Territory (8% and 13.8% respectively, in 1994). Alalthough there is no documentation, it is very likely that Sakhalin Island's salmon populations have been substantially simplified genetically and through the loss of seasonal races. A handful of Russian salmon runs have been extirpated (Pacific Rim Project, forthcoming).

Japanese salmon populations have likely been most extensively simplified. The degree of genetic, demographic and seasonal racial diversity prior to extensive hatchery operations is either unpublished or unknown. Chum and pink salmon runs have been virtually completely captured and manipulated as hatchery broodstock, although there are anecdotal reports of some natural spawning above hatchery weirs (Okamoto, 2000). Only cherry salmon are confirmed to have remnant wild spawning populations, and these are fished very heavily as juveniles by anglers in freshwater as well as by commercial harvesters in saltwater during their spawning migration. Kaeriyama (1999a, 165) indicates concern over maintaining the natural adaptability and fitness of hatchery salmon (genetic diversity), and proposes a rigorous biological monitoring program to improve information about trends in population demography and seasonal races.

Pacific Northwest salmon populations have also been greatly simplified. The diversity of habitats in the region supported all of the Pacific salmon species but cherry salmon, and these species had a wide diversity of life history strategies. No commercial species is extinct, but wild salmon have been extirpated from several portions of their pre-settlement range. Whereas five species were once harvested commercially in the Columbia River, there are only limited chinook and coho fisheries remaining. Selective fishing pressures and widespread habitat alteration, in combination with over one hundred years of hatchery practices, probably have altered the genetic (Reisenbichler and Rubin, 1999) and life history composition of many salmon populations (Huntington et al., 1996, 10-11).

British Columbia's rich array of salmon populations fared better than those in the contiguous United States for many years, because of a shorter history of intensive hatchery manipulation and a century-long management focus on escapement by river basin and subbasin. Nonetheless, the recent combination of heavy fishing pressure in mixed hatchery-wild stock fisheries, steady habitat loss, and a sudden change to unfavorable ocean conditions caused salmon populations in many river basins to decline by the late 1980s (Slaney et al., 1996).

11.4 How have property rights affected salmon harvest trends and salmon management philosophies?

Two broad arguments can be made regarding the effect of property rights on salmon harvest trends and management philosophies. First, where harvesters hold management rights allowing them to exclude others from fisheries profit-taking, salmon populations tend to be fully utilized to maximize the income and stability of the community of harvesters (e.g., Japan, arguably in pre-colonization Russia, Alaska, British Columbia and the contiguous US). Harvestable biomass is the principal objective, and hatchery production is an adequate substitute for wild salmon, as long as it meets or matches the competition in the marketplace.

Conversely, where harvest and management rights are split between commercial harvesters (corporate and individual) and government, respectively, commercial harvesters diminish in number over time as salmon populations decline (e.g., contiguous United States, British Columbia). Despite government-funded hatchery supplementation, the entry of new harvesters or the increasing technical sophistication of a fixed pool of harvesters is always more than sufficient to harvest all of the available salmon.

Secondly, both the diversity of harvesters and their level of political leverage appear to affect management philosophies. The greater the diversity of harvesters with clear legal rights, the more probable it is that biodiversity will be emphasized over biomass production in the face of declining salmon populations. The paradigmatic cases are the contiguous United States and Japan, the other jurisdictions fall on a spectrum in the middle – British Columbia, Alaska, and Russia.

The diversity of harvesters has always been high in the American Northwest, composed of multiple immigrant ethnic groups, native tribes, gear groups, large corporations and individuals. Sport fishing was already popular by the end of the 19th century, and anglers had begun to form associations to lobby for conservation. Initially, in the context of a laissez-faire, open access fishery, harvester diversity worked against biodiversity management. State fisheries managers opted to use hatchery technology to increase the size of the pie, rather allocating salmon among competing groups and actively regulating harvests.

The diverse groups had difficulty working together in the American Northwest, and harvesters were weak politically and economically. Conservation objectives were often used as an argument in attempts to eliminate competing gear groups through the initiative process. Unlike their Canadian counterparts, United States canners prevented harvesters from unionizing in the 1930s on the basis of anti-trust laws. Commercial harvesters remained a divided community. Tribal fishers were also politically weak until the 1970s, and took an increasingly smaller proportion of the overall harvest.

Anglers in the American Northwest became an increasingly powerful group. They had clear access rights on most rivers, and had ousted commercial harvesters from many areas at the ballot box. Angler licensing was in place by the 1920s in all of the States, and license revenues eventually became a major component of state fisheries agencies' funding. Although also divided into gear groups, sport fishers are generally conservation-oriented. They are a strong lobby for getting salmon and steelhead upstream, into their favorite fishing holes. This presents a strong lobby for life history diversity, with a range of salmonids present in a wide array of habitats across the seasons.

Once the treaty tribes won a right to 50% of the salmon harvest in the Boldt and subsequent judicial decisions, they also became a very strong lobby for returning salmon to the rivers. Their interests are more narrowly focused on returns to usual and customary fishing grounds and tribal reservations. The tribes also do not have a strong preference for wild over hatchery fish. On the Columbia River in particular, any fish is deemed better than no fish at all, as a vehicle to preserve their traditional culture. Nonetheless, the tribes and their treaty rights were the ultimate catalyst for petitions under the Endangered Species Act regarding upriver Columbia salmon runs, and their standing in the courts was instrumental in fostering the philosophical shift to focus on sustaining salmon runs at a subbasin scale.

Japan represents the opposite extreme. The Fishery Cooperative Associations (FCAs) dominate the harvest arena, from the creation of fisheries management plans to the allocation of fishing licenses. Although angling has surged in popularity in Japan since WWII and several associations exist, they do not have very much political clout. Sport fishing is also managed by the FCAs and overseen by the prefectures. All sport-fishing regulations are either FCA promulgated, or prefectural in nature. There are no national sport fishing laws or sports licensing. The Ainu have no aboriginal rights with respect to the fisheries. Thus the Fishery Cooperative Associations, with their primary emphasis on sustained biomass production, determine the principal management philosophy. However, there is potential for change if anglers organize more effectively for habitat protection, sport fisheries regulations, and protection of endangered species.

The British Columbia case is similar to that of the contiguous United States. Initial harvester diversity was also high, but controlled largely by canners through share-based operations with the Japanese and Indian fishers. Angler licensing began in the early 1900s, and angling began to increase in popularity in the teen years. The early management philosophy was based on basin-level escapement targets to assure natural production. Indian harvests suffered, as the food fishery was increasingly constrained in the name of assuring resource conservation, and the Indian fishers were the last in line as the salmon moved upstream.

By the 1950s, commercial harvesters in British Columbia had become a strong and united force, through unionization. The salmon harvests were steady, and harvesters were making good incomes and reinvesting in more efficient vessels to claim a larger share of the bounty. Strong salmon markets because of the collapse of the Alaskan sockeye and pink salmon runs increased entrants to the British Columbia fisheries. Even limited entry at the end of the 1960s did not slow down harvest capacity. Canners interested in reducing fish prices, supported by harvester organizations, lobbied for renewed artificial production and achieved their goal. Then the stocks collapsed in the 1980s.

Declines in fish runs were followed by several landmark rulings on behalf of the Canadian Indians, or First Nations, in the 1990s. Aboriginal fishing rights were found not to have been extinguished, and along with land title, they are being sorted out in a protracted Federal-Provincial-First Nation treaty negotiation process. At present, there are no acknowledged limits to First Nations' fishing rights, except in the case of a conservation emergency. The latter has not yet been defined.

The increase in First Nations' standing and the demand by freshwater anglers for salmon in the rivers has led to a renewed emphasis on individual salmon populations, often at a fine scale. British Columbia and the federal government are now in the process of instituting a wild fish management policy and biologically-based definitions of conservation emergency in order to regain control over fish harvests.

Neither Russia nor Alaska have faced dramatic declines in salmon harvests across the landscape since the 1950s. Both jurisdictions are experiencing problems in specific regions (the Amur fishery in Russia, the Yukon-Kuskokwim fishery in Alaska). They will likely react differently in the face of declines, based on the composition of their harvester communities.

Alaska will likely be steered in the direction of biodiversity management, forced to spend more money on monitoring on a population-specific level in some areas. This is because of the leverage that will be exerted by sport fishers and native interests, in seeing significant returns of fish to specific rivers. The recent federal takeover of native subsistence harvest management on federal lands will also support an emphasis on fish in the rivers.

Russia, on the other hand, does not have either an empowered angling community or native community. The commercial harvesters are the primary lobbying group at the federal and regional level, and larger companies with international connections have more clout than do small local companies. Arguments for a biomass emphasis utilizing hatchery production are likely to predominate as long as hatchery returns remain strong because of favorable marine survival conditions. Given the very large, unorganized mass of personal consumption harvesters and the unsteady nature of the Russian economy, it is unlikely that the government will be able to control fishing effort in the near term, particularly if salmon runs continue to decline. Many salmon runs will likely be extirpated or significantly altered in life history and genetic composition.

11.5 How has changing technology in the salmon fisheries affected harvest trends and salmon management philosophies?

Technological innovation is regarded as a central means to reach management objectives in all of the jurisdictions, whether the objective is maximizing biomass, sustaining fishing communities, or preserving biodiversity. More recently, hatchery technology and its cousin, net-pen aquaculture, have been viewed by some as part of the problem. Hatcheries and harvesters rarely recapture 100% of hatchery returns and some hatchery fish spawn in the wild. Hatchery-produced salmon tend to reduce the reproductive efficiency of wild spawners if they mingle on the spawning grounds. Hatchery substitution for wild salmon runs tends to simplify the genetic diversity of salmon stocks over time, reducing a stock's potential for adaptability over time. Pen-reared salmon create competition for wild capture fisheries, threatening the economic viability of some fishing communities.

On the other hand, technological innovations have had clear, positive effects on harvest trends, and have largely been welcomed by salmon managers. For instance, the perfection of canning technology was critical to the development of commercial salmon industries and associated international markets. Innovations have been adopted rapidly in all jurisdictions with the exception of Soviet Russia.

Some innovations have complicated fishery management and harvest allocations. Vessel and gear innovations, which improved fleet efficiency and mobility, complicated management designed to assure adequate wild salmon reproduction (escapement-based management) in British Columbia and Alaska. In some cases, entire salmon runs have been overharvested before biologists could estimate run sizes. Increases in harvest efficiency also meant that, over time, there were usually too many vessels targeting too few fish. Despite regulations limiting efficiency (e.g., the amount of gear a troller can fish simultaneously, bans on motorized boats), harvesters usually find a way to compete better on the fishing grounds.

Innovations in hatchery technology and the development of strict broodstock protocols to reduce inbreedng facilitated rapid growth in hatchery return rates over the past two decades, particularly for pink, chum and sockeye salmon. There are now robust hatchery-based fisheries for pink and chum in Japan, Russia (Sakhalin), Alaska and intermittently in British Columbia.

11.6 How have international relations among Canada, US, Japan, and Russia influenced jurisdictional harvest trends and salmon management philosophies?

Treaties and conventions formally apportion harvest rights among national jurisdictions. As such, they can be viewed as codifications of shared salmon management philosophies for a given place and time. In this case, it is more interesting and relevant to ask how the underlying international relations made possible the negotiation of agreements, facilitating specific harvest trends.

Japan's harvests have clearly been affected by international relations and harvest access agreements. Japan is the only jurisdiction that has fished for salmon on the high seas. Japanese fisheries in Russia were codified in a bilateral agreement between Russia and Japan after Japan's victory in the Russo-Japanese War. The war was not essential to Japan in order to gain access to Russian-origin salmon, but it provided a degree of access stability that was not present before. Japanese concessions in Russian waters still carried only a one-year term.

U.S.-Japanese relations were paramount in preventing an extension of Japan's high seas fisheries into the Bering Sea. Exploratory mothership operations between 1935-1938 stirred up strong US protests, and were terminated because of Japan's desire to maintain US neutrality, in light of the ongoing Sino-Japanese war in Manchuria.

Japan's defeat in WWII provided a political opportunity to curtail Japanese distant water operations yet further. The Soviet Union evicted Japanese companies from Russian soil, and in the early 1950s constrained high seas interception fisheries to limited times and areas renegotiated on an annual basis. The United States insisted upon a North Pacific fisheries convention as a condition of peace, and was joined by Canada in forging the Tripartite Agreement, which constrained Japan to the high seas west of the 175° W abstention line.

Lastly, détente between the United States and the Soviet Union in the 1980s led to an US-Soviet drive to eliminate high-seas salmon fishing altogether. The North Pacific Anadromous Fisheries Convention, signed in 1992, replaced the Tripartite Convention and created the legal framework for prosecution of any vessel found fishing for salmon on the high seas.

The collapse of the Soviet Union once again gave Japan the upper hand vis-à-vis negotiations with Russia, because of the latter's need for technology and economic aid. Japan once again has direct access to fisheries within Russian waters, as well as a series of joint fishing ventures. Japanese large-scale driftnet operations in the Russian portion of the Bering Sea are currently a source of controversy within the Alaskan fishing industry, as they may be intercepting Western Alaska-origin chum and chinook.

International relations per se have not similarly affected US-Canadian harvests in the Eastern Pacific. Since the turn of the century, it has been difficult for the United States to ratify US-Canada fishing conventions because of internal US conflicts over states' rights to manage fisheries. The 1937 Fraser River Convention was only ratified by the US Congress after the Puget Sound canners lost the right to use pound traps, and a fifty-fifty US-Canadian split in sockeye harvests became a net gain rather than a loss.

Similarly, US internal interjurisdictional fisheries management disputes were a key stumbling block in renegotiation of the 1985 Pacific Salmon Treaty upon expiration in 1992. Alaskan and Contiguous US fisheries managers could not agree on appropriate conservation strategies to put forth under the Treaty.

11.7 How have markets influenced jurisdictional harvest trends and salmon management philosophies?

For the first one hundred years of the international salmon industry, canned salmon was the principal product traded internationally. After WWII, canned salmon faced competition in the traditionally large United States market, and demand began to wane. Alaska still accounts for approximately 2/3s of the global canned salmon trade (Garrod, 1987, 100). International markets have become more varied, with a large proportion of the harvest (between 55-65% of Alaska salmon) now sold fresh or frozen (Garrod, 1987, 100). Some of that product is reprocessed in Europe as smoked fish, or in Japan as dry-salted fish. The restaurant trade, supermarket retail sector, and processed ready-to-eat foods sector all represent growning shares of the market. The biggest change in both international and domestic salmon markets has been the widespread acceptance of pen-reared Atlantic salmon and coho as substitutes for wild-caught fish, particularly in the restaurant and retail sectors.

Competition from pen-reared salmon producers has caused salmon managers and industry analysts in Alaska and Russia to question the emphasis on mass production of pink salmon. Pen-reared production of premium species such as coho, chinook and Atlantic salmon has risen dramatically, has more than tripling in volumetric terms between 1990-1998 (Alaska Seafood Marketing Institute, 1999). One suggested solution is to raise the market profile of specific stocks of wild salmon, to increase their market value, as has been successfully done for Copper River King salmon. Ecotrust, a Pacific Northwest non-profit organization, is one of several participating in an effort to develop "eco-marketing" techniques to promote sustainable harvests of wild and responsibly cultured fishes (Marvin, 2000).

11.8 How has science and advocacy influenced jurisdictional harvest trends and salmon management philosophies?

The Japanese economy is corporatist in nature, with very tight ties between industry and government bureaucracies managing natural resources. The Japan Fisheries Association, the representative association for fisheries units of large Japanese corporations, is very close to the Japan Fisheries Agency and often helps implement agency policies. Similarly, the National Federation of Fishery Cooperative Associations (Zengyoren) is very active in setting and implementing fisheries policy, either directly or through support for efforts by the local Fisheries Cooperative Associations.

The Japanese government funds a network of five regional and two thematic fisheries science and technology research institutes. The central government also founded Ocean Research Institute at Tokyo University. Although there may be independent, non-government-funded fisheries research at some of Japan's universities, it appears that most research is government-sponsored. Most research appears to be technological and problem-oriented, rather than ecological in nature.

Scientists in Russia have been formal advisors to fisheries decision-makers since the 1920s. Scientific advice has been heeded when it supported the principal objective of maximizing protein biomass. The Russian Federation, as Japan, lacks a tradition of civic activism. There are few citizens' groups in the Russian Far East which focus on fisheries issues. The most active groups are based on Kamchatka and Sakhalin, where fisheries are critical to the local economy and sense of place. Many field-level Russian fisheries biologists are strongly conservation-oriented, but lack a means to network and coordinate activities with like-minded colleagues. The pre-Revolutionary Russian Fisheries Society has not been revived, and there is no professional organization for fisheries biologists. Fishermen's newspapers published in each of the territorial units of the Russian Far East, which as the primary means for communication within the fishing community. The Internet is beginning to have an effect on civic activism as well, but is hampered by top-down control of access within many fisheries agencies and research institutes.

Fisheries scientists in Canada have worked on ecological and applied fisheries management problems since the 1920s. Findings regarding salmon migration, population structures, local populations, and so forth have been integrated into escapement targets for the relevant fisheries over the years. Gear and ethnic groups have been the most vocal associations to lobby for changes in salmon management during the past 60 years. More recently, due to several judicial decisions, native

Canadians or "First Nations" have been the most powerful constituency pressing for changes to salmon management.

Fisheries managers in the Pacific Northwest ignored published scientific evidence regarding home stream theory as late as the 1940s. Most fishery managers wanted to believe that hatcheries and interbasin fish transfers would successfully mitigate for river development, habitat damage, and overharvest (Cone and Ridlington, 1996, 33-36). Fisheries managers' interests became tied directly to hatchery programs, which over the years accounted for more than 70% of state agency budgets.

Fisheries biologists have played a greater role in the contiguous United States than in any of the other jurisdictions. The Oregon Chapter of the American Fisheries Society has been particularly active in promoting debates regarding the extinction of salmon runs and the definition of key watersheds and salmon refugia (e.g., Nehlsen, 1991).

11.9 Summary

The major factors shaping present salmon management philosophies in the North Pacific are the initial endowment of salmon species, the landscape, climate variability, and the cultural of the dominant salmon harvesters. Incremental salmon management decisions over time tend to be indicative of changes in the other factors, rather than causal determinants of management philosophy. Change in salmon management philosophies occurs when the legal rights (standing) of salmon harvester subgroups is altered, whether by judicial decision or economic processes. Changes in legal rights to harvest salmon are often accompanied by changes the societal role of salmon.

Japan, for instance, is a small populous nation (378,000 sq km) with a present population density (335.3 people/sq km) an order of magnitude higher than the next most populous jurisdiction. As an island country with limited arable land, it has always been dependent on coastal and marine food resources. Given its location at the confluence of the Kuroshio, Oyashio, Tsushima and Okhotsk current systems and its convoluted shoreline with many protected estuaries and small bays, the coastal waters of Japan are rich in seafoods.

Japan's population is more homogenous than that of any other North Pacific salmon jurisdiction. The ethnic Japanese (Wajin) majority has lived on Honshu for many centuries, and developed strong cultural and economic institutions based upon salmon and seafoods. Fishing and community came to be closely related in a cultural sense. Given limited arable lands, it is not surprising that in feudal Japan sea territories were as important as land territories for food production and taxes, and that sea territories came to be owned in a similar manner as land (importance of fishing community preservation, Table 11.1).

Table 11.1. Present emphasis in salmon management philosophies across the North Pacific.

Jurisdiction	**Biomass Production**	**Community Preservation**	**Biodiversity Conservation**
Japan	High	High	Low
Russia	High	Low	Low
British Columbia	Low	Moderate	High
Alaska	High	High	Moderate
American Northwest	Moderate	Moderate	High

The present-day management system evolved from locally-based management: feudal hans were replaced by prefectures as the regional management agency, and the role of village fishing guilds was formalized through 20th c. legislation as Fishery Cooperative Associations. Producing fish (biomass production) and the persistence of fishing communities are the principal management objectives, shared across the local, prefectural and national level. At the national level, the persistence of the salmon and seafood industry is a matter of national food security.

The dominant interest groups in Japanese salmon management have been large corporations, government hatchery operators and Fishery Cooperative Associations. Their interests are in biomass production to satisfy domestic demand for a daily food item, dry-salted chum, and diversified production for the restaurant and retail trade. Japanese rivers traditionally supported only one premium species – cherry salmon – and it has never been very abundant, and is more difficult than chum salmon to culture. Thus the growing market demand for premium sockeye, coho, chinook and Atlantic salmon is fed largely by overseas producers, and to a small degree by harvests in Russian waters.

There is not a tradition of activism in Japan, and no enfranchised interest group arguing to bring salmon back into the rivers. The Ainu have not been able to raise the profile of naturally reproducing salmon on their own. Japanese freshwater cherry salmon anglers may be able to initiate a debate about the status of cherry salmon populations, but the fragmented local Fishery Cooperative Association management of freshwater sport fisheries makes them a difficult target for change. Even the listing of several anadromous salmonids in the Japanese Red Book has not advanced the issue of managing salmon fisheries for genetic and species biodiversity. Scientific concern about the fitness of hatchery broodstock to adapt to changing climate conditions may be the catalyst that initiates debate in Japan about including biodiversity objectives in fisheries management.

The American Northwest is the most different from Japan in terms of its salmon management philosophy, its cultural and biophysical endowment (Table 11.1). It is 2.8 times greater in area than Japan, and is much less humid. Average river length is significantly longer, and there is a higher proportion of arable land, much of which is irrigated. Pacific salmon are at the edge of their range in the American Northwest, as they are in Japan, but the habitats available are more varied, particularly with regard to precipitation and stream flows. It may be that the great diversity of seasonal races and life history variations of Pacific salmon in the American Northwest evolved to reproduce in a complex variety of habitat niches, across space and time. The predominant American Northwest species (chinook and coho), with complex freshwater life stages, may be less able to withstand the simultaneous pressure of altered freshwater habitat quality and poor marine survival conditions than the more evolved, ecological generalists (chum and pink).

In contrast to Japan, with a fisheries-dependent population and culture in place for several centuries, the population of the Pacific Northwest is currently composed primarily of newcomers who have arrived in the region over the past 150 years. The predominantly Western European immigrants came to the western United States seeking economic independence. They were unfamiliar with Pacific salmon, and as soon as they could till the land the majority of the settlers shifted to a non-fish based diet. By the early 20th century, the principal salmon management philosophy was to produce as much biomass as possible, relying greatly on artificial production to substitute for natural habitat (Table 11.1). Given the aridity of much of the region and the high peak volumes of snow melt runoff, irrigation impoundments became major competitors for water by the early 1900s. American Northwest rivers were also attractive for hydropower generation, given the absence of large deposits of fossil fuels in conjunction with the high volume, high-head rivers (significant drops in elevation over the run of the river). By the 1930s, when the first major hydroelectric facilities were built, the salmon industry was well-established but shrinking, due to declining salmon runs.

The states' emphasis on biomass production continued into the 1970s. Several events occurred that forced a dramatic change in management philosophy toward increased emphasis on the fishery community (Table 11.1). The Boldt Decision allocated a 50% share of salmon harvests to treaty tribes and gave them full standing as co-managers with rights to manage harvest. The tribes and the increasingly stronger sport-fishing population demanded that salmon return to specific rivers, beyond the gauntlet of fisheries and hatcheries in the lower rivers. Climate-drive ocean survival conditions deteriorated, reducing hatchery returns. Lastly, genetic analysis techniques, along with more increased run monitoring, have begun to demonstrate how harvest and hatchery practices have simplified many salmon populations.

Most recently, the tribes, anglers, scientists and conservationists banded together to use endangered species law and the courts to force a change in salmon management, to emphasize biodiversity conservation first, and biomass production second (Table 11.1). Although often allied with the other groups, the tribes and some anglers still favor hatchery production in many instances, believing that hatchery fish in the rivers is better than no fish at all. Fish in the river are equated to cultural survival (Dompier, 1996). Others believe that hatchery production has been a major cause of the decline of the salmon populations, and that it is an inherently inefficient way to produce biomass.

Russia continues to emphasize biomass production over community preservation and biodiversity conservation. Biomass production was a clear policy goal during the Soviet era, given the county's need for protein foods. Community preservation was a secondary goal during the Soviet era. Native communities were initially converted to fishing and hunting collectives to preserve their ethnic identity and initiate a process of integration into the mainstream economy. Both native and Slavic rural communities were relocated in the 1950s and 1960s, when salmon runs declined. At present, although community preservation is a frequent political slogan, there are no proactive policies to support small-scale coastal fishing industry development, in contradiction to the interests of the large, politically connected fishing corporations. Economic survival has been the primary motivation for all constituencies in the Russian salmon industry. The only advocacy for salmonid biodiversity conservation to date has come from Moscow State University and the Wild Salmon Center, in programs funded by the United Nations Development Program Global Environmental Facility Salmonid Biodiversity Conservation Project (Rahr, 2000).

British Columbia continues to emphasize maximum sustained wild salmon production. Time, area and multi-year season closures have been used to protect wild spawning stocks as early as the 1920s. Community preservation has been emphasized intermittently in Canadian salmon management. Early federal cannery licenses stipulated canner the provision of services to local communities. Fishermen became eligible for federal unemployment benefits, even for the winter season, beginning in 1957 (Parsons, 1993, 412-413). The Davis Plan (1968) for limited entry was the first policy that specifically mandated assistance to native communities for economic adjustment. The Salmon Enhancement Program and subsequent vessel buy-back programs have contained funds for assistance to native and other rural communities. Currently, the First Nations-British Columbia-Canada treaty negotiations process is establishing a new framework for native self-determination and fisheries co-management.

Canada's moderate emphasis on biomass production diminished when chinook and coho harvests (1980s) and then pink and sockeye harvests (1990s) began to decline. The Canadian Department of Fisheries and Oceans drafted a Wild Fish Management policy (2000; currently under public review) which charts a new strategy, based on the conservation of wild salmon stocks and salmonid diversity. Since the *Sparrow* decision, there has been no cap on native harvests except as reached in specific agreements between First Nations groupings and the Department of Fisheries and Oceans. The Department can only mandate harvest limits in the case of a "conservation emergency." In addition to meeting angler and native demands for harvestable salmon in the rivers, the draft policy defines dropping below minimum escapement goals to sustain viable wild salmon stocks as a "conservation emergency."

Under federal management, biomass production was the primary emphasis in Alaska. After statehood, long-term sustained wild salmon management took precedence, with greater emphasis on permitting sufficient escapement to sustain wild populations. During the federal era, there was very little emphasis on community preservation. After statehood, the Legislature and the Fisheries Board worked to craft policies that would protect native and non-native fishing-dependent communities, for example the liberal eligibility requirements for limited entry permits under the Limited Entry Act (1974). Alaska's subsistence and personal use fisheries also support rural fishing communities. Alaska's emphasis on biodiversity has been moderate – the state has not faced difficult decisions to protect specific salmon stocks given the record harvests in many areas of the state for the past decade.

11.10 Conclusions

Given Pacific salmon habitat requirements, it may be that large, modern human populations and diverse, abundant salmon populations cannot easily coexist. It is clear that biogeographic and anthropogenic factors affect salmon fisheries at a range of spatial and temporal scales. Upon examination of the fisheries across space and time in the North Pacific, there is an apparent trend toward increased extinction from the more populous southern latitudes to the less populous northern latitudes, despite the differences in management philosophy.

If human populations pose a threat to salmon population viability due to harvest, urbanization, forestry, mining, agriculture, hydroelectric generation, water withdrawals and water contamination, then perhaps the best we can do is perform triage. Evolutionarily significant units of salmonid diversity should be mapped while they are still expressed clearly by distinct salmon populations across the landscape, so that we understand the range of salmonid adaptations to environmental variability. High-functioning salmon rivers in populous areas such as the American Northwest, southern British Columbia, Japan and the southern Russian Far East should be set aside as salmon sanctuaries, as recommended in the 19th century by Livingstone Stone. Harvest should be managed for the economic benefit of local communities. Sufficient spawners should be allowed to escape harvest to guarantee population viability in years with poor environmental conditions. The ecological value of spent salmon as part of the nutrient cycle in salmon river ecosystems should also be accounted for. Lastly, we should improve our understanding of ocean rearing distributions of salmon to better understand the effects of climate variability upon ocean carrying capacity. Current levels of artificial production of pink and chum salmon by Japan, Russia and Alaska may locally overwhelm ocean productivity, harming wild salmon runs of various species.

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APPENDIX

North Pacific Harvest by Species (millions of fish), 1878-1998

Year	SO	PI	CM	CO	CH	Total
1878	1.38	0.01	0.96	0.09	2.07	4.51
1879	0.74	3e-3	1.35	0.03	2.01	4.13
1880	0.53	3e-3	1.16	0.22	2.47	4.38
1881	2.10	0.01	0.87	0.22	3.02	6.22
1882	2.76	0.01	1.48	0.36	3.05	7.67
1883	2.45	0.01	1.02	0.33	3.21	7.01
1884	1.90	0.01	0.59	0.73	3.15	6.38
1885	1.79	4e-3	0.53	0.54	2.83	5.69
1886	1.89	0.01	0.93	0.73	2.10	5.65
1887	3.58	0.01	7.50	0.31	1.69	13.08
1888	4.88	0.01	7.02	0.68	1.95	14.54
1889	10.33	0.15	10.45	1.16	1.25	23.35
1890	10.73	0.01	5.80	0.94	1.29	18.77
1891	9.56	0.13	5.14	1.17	1.27	17.27
1892	7.92	0.01	6.82	1.33	1.29	17.37
1893	14.40	0.44	7.36	1.62	1.26	25.09
1894	14.46	0.89	5.17	1.57	1.41	23.49
1895	13.30	1.19	5.03	3.24	1.67	24.42
1896	16.60	2.33	4.21	2.42	1.60	27.17
1897	24.58	4.77	5.64	2.26	1.82	39.08
1898	19.93	2.22	4.89	2.57	1.51	31.11
1899	25.76	6.99	4.21	3.11	1.49	41.56
1900	24.47	6.75	5.46	2.26	1.48	40.42
1901	45.69	11.85	4.75	1.82	1.21	65.32
1902	32.58	13.09	5.34	2.15	1.82	54.98
1903	29.16	12.30	4.14	2.64	2.13	50.37
1904	26.94	9.71	4.66	3.23	2.52	47.06
1905	44.44	8.86	6	2.67	2.65	64.62
1906	27.21	36.58	8.87	3.53	2.39	78.58
1907	24.09	71.25	18.76	3.55	2.34	119.99
1908	30.76	50.65	18.57	3.37	2.07	105.41
1909	47.97	65.67	34.13	3.19	2.13	153.09
1910	32.32	77.15	60.85	4.58	2.86	177.76
1911	28.92	192.14	48.04	6.33	3.37	278.79
1912	39.93	132.05	42.32	5.61	3.65	223.56
1913	66.59	166.25	50.08	3.58	3.13	289.62
1914	42.89	161.37	45.78	6.27	3.35	259.66
1915	36.85	183.64	33.85	6.59	3.58	264.51
1916	41.90	207.49	27.45	7.43	3.41	287.68
1917	52.57	285.93	36.35	6.17	3.32	384.34
1918	48.15	197.97	47.70	8.47	3.59	305.88

North Pacific Harvest by Species (millions of fish), 1878-1998 (Continued)

Year	SO	PI	CM	CO	CH	Total
1919	34.32	177.44	52.53	9.35	4.53	278.17
1920	36.16	190.61	39.40	4.80	3.32	274.28
1921	38.07	168.72	27.75	4.09	2.71	241.34
1922	54.79	216.21	36.12	5.71	2.55	315.38
1923	50.27	127.32	36.29	6.05	3.25	223.19
1924	42.42	276.32	35.50	7.23	3.76	365.23
1925	31.93	109.36	41.61	7.41	4.30	194.60
1926	52.13	314.04	46.19	6.99	3.37	422.71
1927	38.83	93.77	42.58	17.26	3.91	196.35
1928	57.87	291.98	62.26	7.97	2.74	422.82
1929	43.83	121.08	63.53	6.69	2.90	238.02
1930	39.36	254.52	68.86	9.09	3.37	375.21
1931	31.60	123.84	41.41	5.51	2.98	205.35
1932	39.99	163.88	50.34	6.41	3.20	263.82
1933	44.64	118.40	41.76	5.81	2.86	213.47
1934	55.76	240.99	58.38	9.66	4.24	369.03
1935	23.56	234.29	55.72	10.91	4.19	328.67
1936	55.28	210.58	81.45	13.28	4.74	365.33
1937	56.62	284.90	63.30	9.10	4.26	418.18
1938	62.25	226.02	73.68	9.22	2.80	373.97
1939	47.72	270.12	68.81	7.41	2.65	396.70
1940	27.66	154.19	59.45	7.73	2.82	251.85
1941	34.65	315.99	54.69	9.60	3.85	418.79
1942	34.86	191.49	46.03	9.47	3.29	285.14
1943	39.66	256.61	42.28	7.16	3.51	349.22
1944	28.52	146.46	33	5.26	2.84	216.08
1945	24.88	124.29	32.35	8.30	3.63	193.45
1946	30.73	78.90	37.87	6.69	4.38	158.56
1947	34.96	154.14	35.17	7.63	4.36	236.26
1948	26.92	72.96	34.72	7.69	3.48	145.77
1949	19.85	194.36	35.56	7.92	3.72	261.41
1950	24.39	53.79	39.14	7.25	3.67	128.23
1951	18.67	157.13	43.72	10.36	3.88	233.75
1952	28.01	105.56	28.34	8.22	4	174.12
1953	24.08	161.83	29.25	7.20	3.98	226.34
1954	27.64	89.97	46.56	8.43	4.10	176.70
1955	27.25	182.18	53.22	11.10	4.67	278.40
1956	32.46	157.68	57.27	11.54	4.60	263.55
1957	37.07	210.68	42.06	8.47	3.87	302.15
1958	37.96	144.54	52.22	10.73	3.64	249.09
1959	25.20	161.97	45.28	8.90	3.59	244.94

North Pacific Harvest by Species (millions of fish), 1878-1998 (Continued)

Year	SO	PI	CM	CO	CH	Total
1960	38.83	93.68	44.79	6.90	3.38	187.58
1961	39.92	132.31	35.72	8.50	3.41	219.85
1962	26.66	116.03	38.60	10.83	3.36	195.48
1963	20.40	167.19	38.92	11.26	3.70	241.46
1964	23.02	107.89	42.34	14.84	4.62	192.71
1965	48.70	130.62	36.09	13.31	3.93	232.66
1966	30.58	116.98	44.90	13.48	3.97	209.91
1967	30.04	125.85	38.04	10.56	3.76	208.24
1968	26.08	123.59	35.19	14.21	4.13	203.20
1969	27.03	145.85	25.68	11.06	4.68	214.29
1970	45.28	94.88	40.59	12.56	4.96	198.27
1971	31.54	132.80	40.07	14.88	5.08	224.38
1972	19.09	90.97	47.49	11.77	5.04	174.36
1973	21.86	135.78	42.48	14.08	5.88	220.07
1974	21.09	84.20	45.56	16.48	5.43	172.76
1975	17.73	145.61	47.71	11.82	5.53	228.40
1976	24.75	113.88	46.87	15.86	5.74	207.10
1977	24.92	164.48	41.17	11.02	5.78	247.37
1978	31.90	127.46	41.79	14.08	5.47	220.69
1979	41.02	173.57	48.29	12.68	5.39	280.95
1980	42.44	163	50.98	12.49	5.40	274.30
1981	51.54	181.04	58.47	11.65	4.59	307.29
1982	46.58	133.54	56.69	15.58	5.07	257.46
1983	63.85	183.60	61.80	11.96	3.85	325.06
1984	50.48	143.03	64.35	13.15	3.97	274.99
1985	60.60	204.10	79.55	13	3.99	361.23
1986	50.57	138.33	78.74	16.88	4.70	289.22
1987	49.33	148.06	67.80	11.84	5.24	282.26
1988	40.11	113.64	85.64	12.31	5.42	257.12
1989	65.70	235.71	73.55	12.33	4.22	391.51
1990	77.04	168.74	89.57	13.24	3.86	352.45
1991	64.17	327.54	79.75	12.79	3.14	487.39
1992	76.52	146.43	74.72	12.46	2.99	313.12
1993	94.78	220.73	89.08	10.13	3.25	417.99
1994	73.06	229.82	106.41	13.83	2.79	425.91
1995	77.46	260.23	116.48	9.69	3.22	467.08
1996	65.03	201.96	122.47	8.44	2.33	400.23
1997	50.94	229.20	103.29	3.45	2.74	389.62
1998	31.74	263.39	97.46	5.32	2	399.92

American Northwest Harvest (thousands of metric tons), 1864-1994

Year	SO	PI	CM	CO	CH	Total
1864					73	73
1865					73	73
1866					145	145
1867					653	653
1868					1016	1016
1869					3629	3629
1870					5443	5443
1871					7258	7258
1872					9072	9072
1873					9072	9072
1874					12791	12791
1875					13717	13717
1876					16692	16692
1877					14878	14878
1878					18463	18463
1879					17921	17921
1880					21891	21891
1881					26534	26534
1882				181	26900	27081
1883				9	27847	27856
1884				47	25951	25998
1885					23627	23627
1886					18155	18155
1887					14243	14243
1888					16232	16232
1889	549	146	187	4855	13407	19144
1890	1769		417	2491	13451	18128
1891	679	342	463	2289	13327	17100
1892	2160		1501	4010	13236	20907
1893	2676	636	1187	3565	12031	20095
1894	2868	328	1257	4516	14716	23685
1895	2920	1030	3446	9967	17415	34778
1896	3172		1422	7031	16553	28178
1897	11724	2078	1165	7656	19354	41977
1898	11201		1682	8269	15583	36735
1899	18870	9289	2974	11727	14387	57247
1900	8745		4543	7549	13956	34793
1901	38733		2639	5559	10007	56938
1902	11649		5598	5237	17697	40181
1903	5571	6580	950	5730	20641	39472
1904	4585		3952	8478	25120	42135

American Northwest Harvest (thousands of metric tons), 1864-1994 (Continued)

Year	SO	PI	CM	CO	CH	Total
1905	28954	2576	3508	5732	15630	56400
1906	5885		7088	7950	21549	42472
1907	3034	15728	2975	8154	20357	50248
1908	5488	220	3074	8564	18012	35358
1909	38757	13465	3402	8891	17557	82072
1910	7800	4	8830	12104	23666	52404
1911	4209	38399	7772	17147	28892	96419
1912	5829	25	4183	10298	22338	42673
1913	60764	41635	3382	5454	20493	131728
1914	10810	217	13389	11799	21949	58164
1915	2217	19343	19643	10099	24525	75827
1916	2645	199	25203	11299	25297	64643
1917	14160	34926	10829	8469	23563	91947
1918	2749	231	11162	15513	23286	52941
1919	2389	12197	23643	12789	26474	77492
1920	1964	51	2419	2172	22995	29601
1921	3522	11517	1324	3786	18761	38910
1922	4097	66	2925	9017	14140	30245
1923	4218	15036	4481	9188	16819	49742
1924	4959	226	6903	12369	24261	48718
1925	8600	16016	6274	11899	24454	67243
1926	3550	58	6393	11214	18637	39852
1927	6767	18776	6725	10526	20114	62908
1928	4012	572	10146	8572	15215	38517
1929	8486	13338	10307	10247	15661	58039
1930	22025	123	5747	10989	16922	55806
1931	6106	25372	5168	8859	17774	63279
1932	5316	31	7187	9329	14835	36698
1933	10779	17508	3661	6995	15756	54699
1934	22212	86	4852	8544	15001	50695
1935	2136	15192	4381	13761	12929	48399
1936	1594	64	5583	6714	14113	28068
1937	3103	13266	5165	7645	15452	44631
1938	4874	21	5470	7194	10514	28073
1939	1897	10607	2562	8402	10513	33981
1940	2666	68	4222	7312	13650	27918
1941	5809	5271	7480	6746	14772	40078
1942	9631	37	8116	3737	14545	36066
1943	888	2538	2997	4325	11219	21967
1944	1080	11	2054	5589	13912	22646
1945	2212	15375	2901	7344	15842	43674

American Northwest Harvest (thousands of metric tons), 1864-1994 (Continued)

Year	SO	PI	CM	CO	CH	Total
1946	10028	1	7409	4750	17251	39439
1947	883	24476	3385	7843	17319	53906
1948	2979	1	5539	6722	14471	29712
1949	3260	20062	2701	6207	11366	43596
1950	4092	21	5877	8106	10835	28931
1951	3751	15412	5618	7389	12225	44395
1952	3901	5	5488	10208	11760	31362
1953	5711	15644	2824	6547	11302	42028
1954	15998	1	4151	4117	11191	35458
1955	2975	14375	2099	5540	14077	39066
1956	3001	2	1076	7316	13263	24658
1957	4132	7969	1138	5601	9150	27990
1958	15025	10	2834	4527	7632	30028
1959	4717	6203	2842	3625	7733	25120
1960	3248	5	960	1833	7234	13280
1961	3817	2230	914	5391	8905	21257
1962	2314	14	1222	5704	7854	17108
1963	3615	14287	1402	4851	8627	32782
1964	1427	7	1430	7895	8299	19058
1965	2730	2203	909	9216	9173	24231
1966	4193	67	1950	11511	7444	25165
1967	5666	10591	1335	11283	6800	35675
1968	2520	12	2517	7788	6932	19769
1969	4404	2844	974	6113	8161	22496
1970	3971	20	1318	14511	9493	29313
1971	8449	5824	769	13101	8738	36881
1972	3253	6	4323	7960	8534	24076
1973	7013	5848	3073	10209	13164	39307
1974	7499	3	2124	13343	8976	31945
1975	4334	3757	1025	9821	10765	29702
1976	3615	3	4144	12387	9695	29844
1977	5150	6281	2273	7070	10618	31392
1978	4120	8	6426	6779	8475	25808
1979	4844	10669	618	8003	8815	32949
1980	1365	6	4767	7498	8332	21968
1981	3419	9214	2744	5398	6847	27622
1982	8367	1	5482	7602	9025	30477
1983	1117	4105	2544	5223	5559	18548
1984	4568	0	3556	4489	5755	18368
1985	7780	9040	5407	5688	7635	35550
1986	7164	0	5858	10045	11450	34517

American Northwest Harvest (thousands of metric tons), 1864-1994 (Continued)

Year	SO	PI	CM	CO	CH	Total
1987	5223	4450	6547	8324	14328	38872
1988	2586	0	8425	7593	16223	34826
1989	5878	7335	4085	7172	10669	35139
1990	5498	0	5111	5934	7721	24264
1991	4776	7015	4732	7220	5387	29130
1992	1608	1	6351	3139	4561	15660
1993	6304	3939	4363	1893	4652	21150
1994	4836	0	6031	2668	4611	18147

North Pacific Harvest by Jurisdiction (millions of fish), 1878-1998

Year	Japan	Russia	Canada	Alaska	AmNW	Total
1878	0.96		1.50	0.06	2.05	4.57
1879	1.35		0.79	0.07	1.99	4.20
1880	1.16		0.78	0.07	2.44	4.45
1881	0.87		2.40	0.09	2.95	6.31
1882	1.48		3.09	0.18	3.04	7.79
1883	1		2.62	0.30	3.10	7.01
1884	0.58		2.48	0.43	2.90	6.39
1885	0.50		2.07	0.64	2.63	5.84
1886	0.80		2.06	1.27	2.02	6.16
1887	7.38		2.82	2.06	1.58	13.84
1888	7.01		2.48	4.18	1.81	15.48
1889	10.39		5.14	6.61	2.42	24.56
1890	5.69		4.98	6.63	2.71	20
1891	5.02		3.83	7.70	2.12	18.66
1892	6.48		3.03	5.12	3.41	18.03
1893	7.09		7.40	7.27	3.33	25.09
1894	5.22		6.10	8.51	3.66	23.49
1895	4.43		6.83	7.59	5.57	24.42
1896	4.24		7.17	11.54	4.22	27.17
1897	5.62		12.07	13.03	8.36	39.08
1898	4.71		5.85	12.90	7.66	31.11
1899	3.70		9.03	14.36	14.47	41.56
1900	3.85	2.30	5.99	21.55	6.74	40.42
1901	3.88	3.22	14.56	27.17	16.49	65.32
1902	2.83	3.57	8.84	31.80	7.94	54.98
1903	3.58	2.73	6.41	30.10	7.56	50.37
1904	2.61	2.67	6.92	28.64	6.23	47.06
1905	3.52	3.43	15.01	27.26	15.40	64.62
1906	12.06	18.59	9.67	31.32	6.93	78.58
1907	20.31	45.78	8.28	34.65	10.97	119.99
1908	19.97	28.80	8.58	42.30	5.75	105.41
1909	29.75	52.45	12.87	34.94	23.08	153.10
1910	45.43	78.15	11.77	33.47	8.94	177.76
1911	89.44	107.32	14.28	44.31	23.45	278.79
1912	65.24	72.78	15.61	63.14	6.78	223.56
1913	83.44	86.16	19.39	59.32	41.32	289.62
1914	88.76	87.79	17.11	54.98	11.02	259.66
1915	97.66	68.65	18.21	63.66	16.33	264.51
1916	104.56	89.06	13.70	69.75	10.61	287.68
1917	123.36	124.94	20.11	91.57	24.36	384.34
1918	73.80	101.03	20.52	102.05	8.48	305.88

North Pacific Harvest by Jurisdiction (millions of fish), 1878-1998 (Continued)

Year	Japan	Russia	Canada	Alaska	AmNW	Total
1919	97.10	88.33	20.20	57.37	15.17	278.17
1920	95.50	92.60	18.52	64.07	3.59	274.28
1921	112.61	71.87	10.02	38.58	8.27	241.34
1922	114.70	102.87	20.49	72.28	5.04	315.38
1923	62.83	50.71	19.98	78	11.67	223.19
1924	129	119.20	26.90	82.89	7.23	365.22
1925	46.52	46.65	22.86	64.72	13.86	194.60
1926	144.66	146.22	28.18	97.87	5.78	422.71
1927	60.88	57.72	16.67	48.24	12.83	196.35
1928	140.86	160.68	27.10	88.75	5.42	422.82
1929	69.47	64.64	17.91	71.95	14.05	238.02
1930	103.66	145.37	37.64	80.57	7.95	375.21
1931	70.66	38.66	12.79	70.45	12.80	205.35
1932	88.27	82.17	15.06	73.18	5.14	263.82
1933	71.01	31.36	19.12	80.67	11.30	213.47
1934	151.18	71.29	25.75	114.45	6.82	369.48
1935	146.92	75.18	22.66	71.84	12.54	329.14
1936	136.68	67.76	29.46	127.52	5.17	366.59
1937	189.80	85.84	23.30	109.74	11.06	419.74
1938	157.32	90.03	20.41	101.91	5.31	374.98
1939	197.52	93.84	18.90	79.28	8.15	397.69
1940	88.45	57.64	16.06	85.31	5.19	252.65
1941	205.04	78.45	22.49	104.28	9.15	419.42
1942	101.16	75.80	21.03	81.38	7.15	286.52
1943	125.75	110.80	21.25	87.67	4.54	350.01
1944	33.02	96.07	13.08	70.86	3.97	217
1945	4.66	78.01	25.36	75.60	11.22	194.85
1946	3.56	54.98	20.87	73.05	8.88	161.34
1947	5.65	119.69	26.48	70.79	15.06	237.68
1948	4.25	59.29	18.87	59	6.08	147.48
1949	4.29	145.68	21.57	78.69	13.01	263.25
1950	6.37	47.72	23.28	45.38	6.15	128.90
1951	6.57	138.11	27.89	49.99	11.97	234.54
1952	38.02	58.74	23.04	48.73	6.90	175.43
1953	36.31	115.22	26.57	37.50	12.60	228.20
1954	50.66	51.84	22.28	44.90	9.19	178.86
1955	123.75	84.95	20.19	40.06	11.26	280.21
1956	111.83	77.36	17.80	51.31	6.40	264.70
1957	141.20	96.47	21.68	34.89	9.48	303.71
1958	133.78	37.81	27.68	41.51	9.08	249.87
1959	140.45	55.01	16.71	25.65	8.23	246.05

North Pacific Harvest by Jurisdiction (millions of fish), 1878-1998 (Continued)

Year	Japan	Russia	Canada	Alaska	AmNW	Total
1960	99.68	28.95	12.22	43.64	3.66	188.14
1961	113.17	37.20	18.81	45.90	6.10	221.19
1962	70.13	24.97	33.46	63.62	4.70	196.88
1963	111.02	51.34	20.72	48.01	12.48	243.58
1964	79.93	19.71	21.30	66.79	5.32	193.05
1965	109.92	43.90	14.79	57.51	7.31	233.43
1966	82.31	26.34	29.99	64.87	7.33	210.83
1967	106.64	46.08	23.08	21.45	12.03	209.28
1968	79.74	18.41	36.33	63	6.63	204.12
1969	103.21	49.51	12.38	42.67	7.49	215.25
1970	74.81	19.90	27.31	69.49	8.07	199.57
1971	91.15	49.62	23.38	48.26	13.24	225.65
1972	87.18	18.16	29.46	32.63	7.48	174.91
1973	108.49	50.08	26.45	23.10	12.57	220.69
1974	89.39	27.27	23.58	23.06	10.57	173.87
1975	112.01	67.06	13.31	27.24	9.72	229.34
1976	84.92	42.92	23.81	45.41	11.05	208.11
1977	78.48	83.16	24.33	52.08	10.47	248.51
1978	56.83	45.18	27.60	83.64	8.12	221.37
1979	75.47	79.06	25.23	90.17	12.18	282.11
1980	74	61.69	20.89	111.77	6.66	275.01
1981	82.67	67.16	33.22	114.84	10.44	308.33
1982	75.37	38.57	21.92	113.45	9.24	258.54
1983	71.19	82.03	37.22	129.48	6.17	326.09
1984	67.77	46.87	20.94	135.37	5.43	276.37
1985	81.39	77.14	43.75	148.34	12.34	362.95
1986	67.61	40.21	41.78	130.57	10.46	290.63
1987	63.47	82.06	27.20	98.76	11.83	283.32
1988	66.69	39.77	39.47	102.61	9.36	257.90
1989	70.59	114.84	38.71	156.37	11.84	392.36
1990	80.59	66.67	41.25	157.05	7.52	353.09
1991	77.44	166.82	42.67	190.77	10.49	488.19
1992	68.40	75.41	27.67	138.50	4.45	314.43
1993	87.90	89.84	36.96	196.06	7.99	418.75
1994	97.20	102.50	24.03	198.24	4.65	426.62
1995	101.10	117.64	22.63	219.55	6.59	467.50
1996	111.90	93.90	15.29	176.58	3.16	400.83
1997	95.40	147.60	19.75	122.01	5.66	390.42
1998	83.50	152.50	8.87	153.11	2.53	400.52

Japan Coastal and Offshore Harvest (millions of fish), 1868-1998

Year	CM	PI&CY	Total
1868	1.14		1.14
1869	0.93		0.93
1870	1.03		1.03
1871	1.46		1.46
1872	1.03		1.03
1873	0.90		0.90
1874	0.12		0.12
1875	0.91		0.91
1876	0.87		0.87
1877	0.73		0.73
1878	0.96		0.96
1879	1.35		1.35
1880	1.16		1.16
1881	0.87		0.87
1882	1.48		1.48
1883	1		1
1884	0.58		0.58
1885	0.50		0.50
1886	0.80		0.80
1887	7.38		7.38
1888	7.01		7.01
1889	10.39		10.39
1890	5.69		5.69
1891	5.02		5.02
1892	6.48		6.48
1893	7.09	0.01	7.09
1894	4.87	0.35	5.22
1895	4.25	0.19	4.43
1896	3.89	0.35	4.24
1897	5.37	0.25	5.62
1898	4.48	0.22	4.71
1899	3.48	0.22	3.70
1900	3.60	0.24	3.85
1901	3.59	0.29	3.88
1902	2.55	0.28	2.83
1903	3.24	0.35	3.58
1904	2.32	0.29	2.61
1905	2.85	0.67	3.52
1906	3.33	0.82	4.15
1907	3.22	1.36	4.58
1908	2.38	1.68	4.06

Japan Coastal and Offshore Harvest (millions of fish), 1868-1998 (Continued)

Year	CM	PI&CY	Total
1909	1.64	2.17	3.81
1910	2.92	8.25	11.17
1911	4.56	14.63	19.19
1912	3.17	13.22	16.38
1913	2.45	22.54	24.99
1914	3.17	5.88	9.06
1915	4.94	19.47	24.40
1916	2.30	7.65	9.95
1917	3.11	14.89	18
1918	3.55	7.83	11.38
1919	5.11	12.06	17.17
1920	3.46	6.80	10.25
1921	3.19	10.54	13.73
1922	3.09	5.39	8.47
1923	4.99	8.41	13.40
1924	2.38	7.10	9.48
1925	3.65	8.43	12.09
1926	4.72	11.55	16.27
1927	3.60	8.59	12.19
1928	2.13	8.34	10.46
1929	3.79	24.50	28.29
1930	4.01	11.95	15.97
1931	3.62	27.57	31.19
1932	2.17	8.67	10.84
1933	2.30	13.98	16.28
1934	4.69	24.29	28.99
1935	5.63	29.68	35.31
1936	3.65	39.15	42.79
1937	3.56	66.81	70.37
1938	5.41	51.06	56.47
1939	4.61	69.41	74.02
1940	3.47	15.93	19.40
1941	2.90	101.59	104.49
1942	2.46	38.02	40.48
1943	2.17	51.49	53.66
1944	1.40	8.71	10.11
1945	2.59	1.53	4.12
1946	2.39	1.17	3.56
1947	2.42	3.22	5.65
1948	2.88	1.37	4.25
1949	3.46	0.82	4.29

Japan Coastal and Offshore Harvest (millions of fish), 1868-1998 (Continued)

Year	CM	PI&CY	Total
1950	5.46	0.91	6.37
1951	6.11	0.47	6.57
1952	2.61	5.24	7.85
1953	2.53	3.18	5.72
1954	3.82	4.08	7.89
1955	2.71	6.09	8.81
1956	2.02	10.96	12.98
1957	3.60	9.57	13.17
1958	3.82	18.19	22.02
1959	2.33	12.82	15.15
1960	2.27	17.23	19.50
1961	3.85	7.23	11.08
1962	4.18	7.56	11.74
1963	4.90	9.16	14.06
1964	5.26	5.57	10.83
1965	6.63	9.46	16.08
1966	5.55	9.63	15.19
1967	6.39	14.78	21.17
1968	3.38	11.53	14.91
1969	5.67	16.71	22.39
1970	7.15	8.97	16.12
1971	10.13	12.36	22.49
1972	8.62	6.94	15.56
1973	11.48	9.85	21.33
1974	13.02	7.32	20.33
1975	20.01	10.50	30.51
1976	12.42	8.57	20.98
1977	15.24	7	22.23
1978	18.22	7.17	25.38
1979	27.98	6.38	34.37
1980	25.78	6.39	32.17
1981	33.60	6.66	40.26
1982	30.02	5.70	35.72
1983	37	6	43
1984	38	6	44
1985	51	9	60
1986	49	6	55
1987	43	8	51
1988	51	7	58
1989	55	7	62
1990	68	6	74

Japan Coastal and Offshore Harvest (millions of fish), 1868-1998 (Continued)

Year	CM	PI&CY	Total
1991	60	16	76
1992	46	11	57
1993	61	17	78
1994	69	20	89
1995	78	11	89
1996	87	16	103
1997	74	12	86
1998	61	13	74

Japan Distant Water Harvest (millions of fish), 1868-1998

Year	SO	PI	CM	CO	CH	Total
1868						0
1869						0
1870						0
1871						0
1872						0
1873						0
1874						0
1875						0
1876						0
1877						0
1878						0
1879						0
1880						0
1881						0
1882						0
1883						0
1884						0
1885						0
1886						0
1887						0
1888						0
1889						0
1890						0
1891						0
1892						0
1893						0
1894						0
1895						0
1896						0
1897						0
1898						0
1899						0
1900						0
1901						0
1902						0
1903						0
1904						0
1905	0	0	0	0	0	0
1906	0	7.62	0.29	0	0	7.91
1907	0	15.51	0.23	0	0	15.74
1908	0	12.82	3.10	0	0	15.91

Japan Distant Water Harvest (millions of fish), 1868-1998 (Continued)

Year	SO	PI	CM	CO	CH	Total
1909	1.26	19.51	5.17	0	0	25.94
1910	1.91	20.13	12.22	0	0	34.26
1911	1.79	59.86	8.60	0	0.01	70.25
1912	1.30	40.26	7.29	0	0.01	48.86
1913	2.51	43.93	11.99	0	0.03	58.45
1914	0.86	67.81	11.02	0	0.01	79.70
1915	1.97	65.53	5.74	0	0.02	73.26
1916	2.94	87.47	4.18	0	0.02	94.62
1917	2.42	95.83	7.08	0	0.02	105.35
1918	4.58	47.66	10.17	0	0.01	62.42
1919	5.70	61.12	13.06	0	0.05	79.93
1920	4.18	69.47	11.53	0	0.07	85.24
1921	5.66	82.40	10.76	0	0.07	98.89
1922	10.59	85.02	10.58	0	0.04	106.23
1923	8.35	31.56	9.50	0	0.03	49.43
1924	8.21	105.85	5.44	0	0.02	119.52
1925	4.33	22.45	6.59	1.03	0.04	34.44
1926	6.56	115.03	5.91	0.82	0.08	128.39
1927	6.94	23	8.15	10.50	0.10	48.69
1928	12	102.26	15.09	0.99	0.07	130.40
1929	7.98	16.59	15.75	0.78	0.08	41.19
1930	8.20	61.83	16.02	1.53	0.12	87.70
1931	6.17	21.53	11	0.69	0.08	39.47
1932	7.43	57.22	12.19	0.52	0.08	77.43
1933	7.17	32.95	14.18	0.40	0.04	54.74
1934	15.84	82.61	22.69	0.97	0.07	122.19
1935	6.66	82.58	20.59	1.67	0.12	111.61
1936	12.33	36.26	40.33	4.85	0.12	93.88
1937	15.96	71.78	28.37	3.16	0.16	119.43
1938	16.65	50.70	31.26	2.13	0.12	100.85
1939	14.16	83.15	24.60	1.51	0.07	123.50
1940	8.94	34.09	25.08	0.86	0.08	69.04
1941	10.06	67.63	22.13	0.65	0.08	100.56
1942	8	33.98	17.65	1.01	0.05	60.69
1943	6.56	58.14	6.97	0.42	0.01	72.10
1944	2.74	17.52	2.47	0.18	0	22.91
1945	0.25	0	0.24	0.04	0	0.54
1946	0	0	0	0	0	0
1947	0	0	0	0	0	0
1948	0	0	0	0	0	0
1949	0	0	0	0	0	0

Japan Distant Water Harvest (millions of fish), 1868-1998 (Continued)

Year	SO	PI	CM	CO	CH	Total
1950	0	0	0	0	0	0
1951	0	0	0	0	0	0
1952	0.83	27.86	1.33	0.15	0.01	30.17
1953	1.77	23.97	4.21	0.62	0.03	30.59
1954	4.17	24.51	12.09	1.90	0.11	42.77
1955	13.01	71.49	26	4.32	0.13	114.95
1956	10.57	61.20	22.66	4.27	0.16	98.85
1957	20.60	89.65	16.54	1.16	0.08	128.03
1958	12.95	65.21	29.28	4.23	0.10	111.77
1959	9.99	89.11	23.38	2.67	0.15	125.30
1960	14.58	42.14	20.68	2.48	0.31	80.18
1961	14.23	72.38	13.55	1.80	0.12	102.08
1962	10.75	29.18	15.39	2.83	0.25	58.39
1963	8.92	69.24	15.21	3.40	0.19	96.96
1964	7.21	36.78	19.34	5.16	0.62	69.10
1965	12.20	62.71	15.55	3.09	0.29	93.84
1966	7.96	34.62	22.29	1.93	0.33	67.12
1967	10.65	53.88	19.13	1.56	0.24	85.47
1968	9.14	35.62	17.28	2.32	0.46	64.83
1969	8.43	54.19	12.92	4.64	0.64	80.83
1970	9.96	28.53	17.17	2.44	0.59	58.68
1971	6.58	42.16	16.75	2.83	0.35	68.66
1972	6.90	38.95	22.35	3.04	0.37	71.61
1973	5.93	60.47	15.69	4.79	0.28	87.17
1974	5.44	36.60	21.81	4.65	0.55	69.05
1975	5.15	52.75	19.24	4.05	0.30	81.50
1976	5.81	31.69	22.37	3.58	0.49	63.94
1977	2.80	39.18	12.23	1.80	0.24	56.25
1978	3.18	17.55	7.29	3.12	0.32	31.45
1979	2.94	30.26	6.14	1.48	0.29	41.11
1980	3.20	29.59	6.27	1.89	0.87	41.83
1981	3.07	31.55	5.63	1.91	0.26	42.41
1982	2.46	27.78	6.74	2.39	0.27	39.64
1983	2.50	18	6	1.42	0.27	28.19
1984	1.90	14	6	1.68	0.19	23.77
1985	1.30	15	4	0.90	0.19	21.39
1986	0.90	8	3	0.55	0.17	12.61
1987	0.80	8	3	0.50	0.17	12.47
1988	0.30	6	2	0.30	0.09	8.69
1989	0.30	7	1	0.21	0.08	8.59
1990	0.30	5	1	0.22	0.08	6.59

Japan Distant Water Harvest (millions of fish), 1868-1998 (Continued)

Year	SO	PI	CM	CO	CH	Total
1991	0.20	0	1	0.16	0.07	1.44
1992	2.40	3	6	0	0	11.40
1993	2.80	3	4	0	0.10	9.90
1994	1.20	1	6	0	0	8.20
1995	2.10	2	8	0	0	12.10
1996	1.90	1	6	0	0	8.90
1997	3.40	1	5	0	0	9.40
1998	2.50	2	5	0	0	9.50

Japan Total Harvest (millions of fish), 1868-1998

Year	DW	C&O	Total
1868		1.14	1.14
1869		0.93	0.93
1870		1.03	1.03
1871		1.46	1.46
1872		1.03	1.03
1873		0.90	0.90
1874		0.12	0.12
1875		0.91	0.91
1876		0.87	0.87
1877		0.73	0.73
1878		0.96	0.96
1879		1.35	1.35
1880		1.16	1.16
1881		0.87	0.87
1882		1.48	1.48
1883		1	1
1884		0.58	0.58
1885		0.50	0.50
1886		0.80	0.80
1887		7.38	7.38
1888		7.01	7.01
1889		10.39	10.39
1890		5.69	5.69
1891		5.02	5.02
1892		6.48	6.48
1893		7.09	7.09
1894		5.22	5.22
1895		4.43	4.43
1896		4.24	4.24
1897		5.62	5.62
1898		4.71	4.71
1899		3.70	3.70
1900		3.85	3.85
1901		3.88	3.88
1902		2.83	2.83
1903		3.58	3.58
1904		2.61	2.61
1905		3.52	3.52
1906	7.91	4.15	12.06
1907	15.74	4.58	20.31
1908	15.91	4.06	19.97

Japan Total Harvest (millions of fish), 1868-1998 (Continued)

Year	DW	C&O	Total
1909	25.94	3.81	29.75
1910	34.26	11.17	45.43
1911	70.25	19.19	89.44
1912	48.86	16.38	65.24
1913	58.45	24.99	83.44
1914	79.70	9.06	88.76
1915	73.26	24.40	97.66
1916	94.62	9.95	104.56
1917	105.35	18	123.36
1918	62.42	11.38	73.80
1919	79.93	17.17	97.10
1920	85.24	10.25	95.50
1921	98.89	13.73	112.61
1922	106.23	8.47	114.70
1923	49.43	13.40	62.83
1924	119.52	9.48	129
1925	34.44	12.09	46.52
1926	128.39	16.27	144.66
1927	48.69	12.19	60.88
1928	130.40	10.46	140.86
1929	41.19	28.29	69.47
1930	87.70	15.97	103.66
1931	39.47	31.19	70.66
1932	77.43	10.84	88.27
1933	54.74	16.28	71.01
1934	122.19	28.99	151.18
1935	111.61	35.31	146.92
1936	93.88	42.79	136.68
1937	119.43	70.37	189.80
1938	100.85	56.47	157.32
1939	123.50	74.02	197.52
1940	69.04	19.40	88.45
1941	100.56	104.49	205.04
1942	60.69	40.48	101.16
1943	72.10	53.66	125.75
1944	22.91	10.11	33.02
1945	0.54	4.12	4.66
1946	0	3.56	3.56
1947	0	5.65	5.65
1948	0	4.25	4.25
1949	0	4.29	4.29

Japan Total Harvest (millions of fish), 1868-1998 (Continued)

Year	DW	C&O	Total
1950	0	6.37	6.37
1951	0	6.57	6.57
1952	30.17	7.85	38.02
1953	30.59	5.72	36.31
1954	42.77	7.89	50.66
1955	114.95	8.81	123.75
1956	98.85	12.98	111.83
1957	128.03	13.17	141.20
1958	111.77	22.02	133.78
1959	125.30	15.15	140.45
1960	80.18	19.50	99.68
1961	102.08	11.08	113.17
1962	58.39	11.74	70.13
1963	96.96	14.06	111.02
1964	69.10	10.83	79.93
1965	93.84	16.08	109.92
1966	67.12	15.19	82.31
1967	85.47	21.17	106.64
1968	64.83	14.91	79.74
1969	80.83	22.39	103.21
1970	58.68	16.12	74.81
1971	68.66	22.49	91.15
1972	71.61	15.56	87.18
1973	87.17	21.33	108.49
1974	69.05	20.33	89.39
1975	81.50	30.51	112.01
1976	63.94	20.98	84.92
1977	56.25	22.23	78.48
1978	31.45	25.38	56.83
1979	41.11	34.37	75.47
1980	41.83	32.17	74
1981	42.41	40.26	82.67
1982	39.64	35.72	75.37
1983	28.19	43	71.19
1984	23.77	44	67.77
1985	21.39	60	81.39
1986	12.61	55	67.61
1987	12.47	51	63.47
1988	8.69	58	66.69
1989	8.59	62	70.59
1990	6.59	74	80.59

Japan Total Harvest (millions of fish), 1868-1998 (Continued)

Year	DW	C&O	Total
1991	1.44	76	77.44
1992	11.40	57	68.40
1993	9.90	78	87.90
1994	8.20	89	97.20
1995	12.10	89	101.10
1996	8.90	103	111.90
1997	9.40	86	95.40
1998	9.50	74	83.50

Amur River Harvest (thousands of metric tons), 1907-1986

Year	Summer Chum	Fall Chum	Pink	Total
1907	14500	21690	1320	37510
1908	6230	18990	6410	31630
1909	32800	33170	2400	68370
1910	50450	40220	7500	98170
1911	34220	24790	3400	62410
1912	23070	22380	6640	52090
1913	26500	28390	7170	62060
1914	8470	13950	14370	36790
1915	8050	11990	810	20850
1916	1540	3500	8150	13190
1917	4650	7450	510	12610
1918	1200	11630	13110	25940
1919	1670	11510	330	13510
1920	620	nd	11900	12520
1921	400	9500	180	10080
1922	1570	21800	8880	32250
1923	2770	6760	130	9660
1924	1450	17310	10770	29530
1925	90	7590	nd	7680
1926	1540	26600	14420	42560
1927	740	19600	230	20570
1928	160	18570	11530	30260
1929	90	17750	nd	17840
1930	4700	19570	7960	32230
1931	4170	25880	440	30490
1932	1550	20740	8010	30300
1933	2230	20920	nd	23150
1934	5960	14710	2710	23380
1935	2350	14320	190	16860
1936	750	15000	2380	18130
1937	1820	12380	150	14350
1938	7300	18700	7070	33070
1939	7070	19300	1880	28250
1940	860	19690	3050	23600
1941	450	10730	1220	12400
1942	1200	8300	8650	18150
1943	2450	20350	1860	24660
1944	420	12480	5560	18460
1945	170	8030	1000	9200
1946	220	6780	6000	13000

Amur River Harvest (thousands of metric tons), 1907-1986 (Continued)

Year	Summer Chum	Fall Chum	Pink	Total
1947	1650	15530	1290	18470
1948	210	10790	12800	23800
1949	200	16930	800	17930
1950	1650	15550	1220	18420
1951	2600	18420	1700	22720
1952	620	9380	810	10810
1953	820	9290	300	10410
1954	50	4190	180	4420
1955	210	11990	100	12300
1956	140	13560	2820	16520
1957	nd	6200	nd	6200
1958	nd	nd	9540	9540
1959	660	8040	600	9300
1960	900	10800	3160	14860
1961	540	9260	100	9900
1962	160	12130	530	12820
1963	850	17540	1100	19490
1964	110	12480	560	13150
1965	150	13550	1000	14700
1966	230	12340	800	13370
1967	300	10900	2000	13200
1968	130	9870	900	10900
1969	190	2490	2000	4680
1970	300	4830	340	5470
1971	370	3010	2000	5380
1972	600	1580	250	2430
1973	300	1220	2910	4430
1974	340	1430	500	2270
1975	550	2090	2000	4640
1976	310	3600	2000	5910
1977	1010	3410	1530	5950
1978	340	2678	3410	6428
1979	540	4250	1000	5790
1980	260	4034	3451	7745
1981	620	2080	2400	5100
1982	700	2600	3200	6500
1983	650	2450	3600	6700
1984	570	1960	4330	6860
1985	1200	1400	3900	6500
1986	1200	1000	3200	5400

British Columbia Harvest (millions of fish), 1878-1998

Year	SO	PI	CM	CO	CH	Total
1878	1.38	0.01	3e-3	0.09	0.02	1.50
1879	0.74	3e-3	2e-3	0.03	0.02	0.79
1880	0.53	3e-3	3e-3	0.22	0.03	0.78
1881	2.10	0.01	2e-3	0.22	0.07	2.40
1882	2.70	0.01	4e-3	0.32	0.06	3.09
1883	2.15	0.01	0.02	0.33	0.11	2.62
1884	1.48	0.01	4e-3	0.72	0.27	2.48
1885	1.30	4e-3	0.03	0.54	0.20	2.07
1886	1.12	0.01	0.13	0.73	0.08	2.06
1887	2.28	0.01	0.12	0.31	0.11	2.82
1888	1.65	0.01	0.01	0.66	0.14	2.48
1889	4.71	0.01	0.02	0.28	0.12	5.14
1890	4.35	0.01	0.03	0.45	0.15	4.98
1891	2.93	2e-3	0.02	0.74	0.14	3.83
1892	2.24	3e-3	0.02	0.59	0.17	3.03
1893	6.73	0.01	0.02	0.48	0.16	7.40
1894	5.62	0.01	0.03	0.33	0.12	6.10
1895	5.99	4e-3	0.04	0.66	0.13	6.83
1896	6.44	4e-3	0.02	0.56	0.15	7.17
1897	11.51	0.01	0.02	0.40	0.13	12.07
1898	5.05	4e-3	0.01	0.63	0.14	5.85
1899	8.19	0.06	0.08	0.52	0.18	9.03
1900	4.70	0.22	0.41	0.47	0.20	5.99
1901	13.02	0.46	0.35	0.52	0.20	14.56
1902	6.22	0.43	1.34	0.69	0.16	8.84
1903	4.36	0.44	0.70	0.71	0.20	6.41
1904	4.09	0.57	1.10	0.93	0.23	6.92
1905	12.57	0.42	0.68	1.07	0.27	15.01
1906	5.55	1.07	1.57	1.12	0.36	9.67
1907	3.91	1.48	1.34	1.23	0.33	8.28
1908	4.33	1.36	1.46	1.10	0.33	8.58
1909	9.35	1.01	1.14	1.03	0.34	12.87
1910	6.97	0.88	1.96	1.42	0.54	11.77
1911	5.04	4.53	2.07	2.04	0.61	14.28
1912	5.63	4.40	2.12	2.26	1.20	15.61
1913	11.56	2.89	2.28	1.80	0.86	19.39
1914	6.42	3.96	2.93	2.82	0.98	17.11
1915	5.65	6.27	1.80	3.54	0.95	18.21
1916	2.59	5.24	2.14	2.96	0.77	13.70
1917	4.23	7.98	4.37	2.75	0.78	20.11
1918	3.32	8.32	4.57	3.29	1.03	20.52

British Columbia Harvest (millions of fish), 1878-1998 (Continued)

Year	SO	PI	CM	CO	CH	Total
1919	4.93	5.66	3.74	4.59	1.28	20.20
1920	4.28	10.20	0.98	2.41	0.64	18.52
1921	2.16	3.83	1.29	2.33	0.41	10.02
1922	3.96	10.72	3.18	2.27	0.37	20.49
1923	4.47	7.92	4.91	2.34	0.34	19.98
1924	5.35	11.78	6.60	2.82	0.35	26.90
1925	5.36	7.69	6.94	2.10	0.77	22.86
1926	4.55	13.63	7.53	1.91	0.57	28.18
1927	4.37	4.19	5.52	1.88	0.71	16.67
1928	2.63	14.36	7.93	1.70	0.48	27.10
1929	3.87	7.61	4.06	1.97	0.40	17.91
1930	5.74	23.92	5.28	2.08	0.62	37.64
1931	3.30	3.30	4.17	1.53	0.49	12.79
1932	3.88	4.03	4.07	2.33	0.75	15.06
1933	3.83	9.44	3.22	2.12	0.52	19.12
1934	4.92	9.31	5	4.52	2	25.75
1935	4.95	7.46	5.18	3.52	1.55	22.66
1936	5.24	12.14	6.28	3.93	1.88	29.46
1937	4.93	10.41	5.04	1.98	0.94	23.30
1938	5.44	7	4.82	2.76	0.38	20.41
1939	4.38	8.90	2.64	2.56	0.42	18.90
1940	4.54	3.80	5.20	2.15	0.38	16.06
1941	5.75	6.20	6.55	3.17	0.82	22.49
1942	8.50	3.92	4.56	3.57	0.48	21.03
1943	2.22	9.55	5.09	3.15	1.24	21.25
1944	2.15	6.65	2.37	1.60	0.32	13.08
1945	4.05	14.58	3.06	3.09	0.58	25.36
1946	7.63	3.44	7.05	1.84	0.90	20.87
1947	4.19	12.44	5.94	2.90	1.01	26.48
1948	3.04	7.03	5.31	2.90	0.59	18.87
1949	3.18	10.95	3.14	3.11	1.21	21.57
1950	4.89	6.89	7.51	2.87	1.12	23.28
1951	4.74	11.93	6	4.30	0.93	27.89
1952	5.22	11.26	2.56	2.95	1.04	23.04
1953	6.37	11.21	4.83	3.05	1.12	26.57
1954	7.21	5.45	6.04	2.59	0.98	22.28
1955	3.05	11.35	1.62	3.17	1	20.19
1956	3.50	7.37	2.54	3.27	1.13	17.80
1957	3.26	11.41	2.49	3.41	1.11	21.68
1958	12.94	6.92	3.30	3.26	1.26	27.68
1959	3.50	6.87	2.08	3.15	1.11	16.71

British Columbia Harvest (millions of fish), 1878-1998 (Continued)

Year	SO	PI	CM	CO	CH	Total
1960	3.07	4.11	1.90	2.27	0.87	12.22
1961	4.90	8.40	1.26	3.48	0.78	18.81
1962	3.76	23.48	1.55	3.84	0.84	33.46
1963	2.24	12.41	1.51	3.65	0.92	20.72
1964	3.89	9.65	2.33	4.37	1.07	21.30
1965	3.24	5.15	0.65	4.66	1.08	14.79
1966	4.32	17.30	1.35	5.72	1.30	29.99
1967	7.24	9.92	1.16	3.51	1.24	23.08
1968	6.73	19.68	3.18	5.54	1.20	36.33
1969	4.58	2.63	1.35	2.59	1.22	12.38
1970	4.33	13.65	3.73	4.22	1.38	27.31
1971	6.59	8.55	1.31	5.20	1.74	23.38
1972	3.81	14.24	6.13	3.55	1.73	29.46
1973	7.90	6.60	6.29	3.94	1.73	26.45
1974	7.58	7.39	2.28	4.55	1.78	23.58
1975	2.68	4.71	1.20	2.84	1.88	13.31
1976	5.20	10.37	1.96	4.18	2.09	23.81
1977	6.79	10.41	1.15	4.06	1.92	24.33
1978	7.65	10.52	3.03	4.50	1.91	27.60
1979	6.22	11.91	0.93	4.44	1.74	25.23
1980	3.55	8.18	3.39	4.11	1.66	20.89
1981	9.08	18.16	1.21	3.32	1.46	33.22
1982	10.88	2.73	3.05	3.74	1.52	21.92
1983	6.14	24.15	1.10	4.61	1.23	37.22
1984	5.73	7.55	1.95	4.16	1.55	20.94
1985	12.84	20.35	5.57	3.79	1.21	43.75
1986	11.32	18.02	5.71	5.61	1.11	41.78
1987	6.11	13.51	2.38	4.16	1.04	27.20
1988	5.13	23.14	6.28	3.93	0.98	39.47
1989	14.62	17.17	1.90	4.04	0.98	38.71
1990	15.17	17.24	3.25	4.64	0.96	41.25
1991	11.35	24.22	2.42	3.79	0.89	42.67
1992	8.56	10.37	4.10	3.70	0.94	27.67
1993	18.77	10.15	4.33	2.79	0.92	36.96
1994	13.15	2.22	4.94	3.06	0.66	24.03
1995	5.57	12.02	2.56	2.11	0.37	22.63
1996	6.31	5.75	1.41	1.65	0.17	15.29
1997	11.13	6.13	1.88	0.26	0.35	19.75
1998	1.89	2.39	4.39	1e-3	0.21	8.87

Alaska Harvest Data (millions of fish), 1878-1998

Year	Total	SO	CH	CM	PN	CO
1878	0.06	0	0	0	0	0
1879	0.07	0	0	0	0	0
1880	0.07	0	0	0	0	0
1881	0.09	0	0	0	0	0
1882	0.18	0.06	0	0	0	0
1883	0.30	0.30	0	0	0	0
1884	0.43	0.43	0	0	0	0
1885	0.64	0.50	0	0	0	0
1886	1.27	0.77	0	0	0	0
1887	2.06	1.30	0	0	0	0
1888	4.18	3.23	0	0	0	0.02
1889	6.61	5.30	0	0	0.09	0.01
1890	6.63	5.34	0.01	0	0	0.04
1891	7.70	6.28	0.01	0	0	0.02
1892	5.12	4.43	0	0	0.01	0.02
1893	7.27	6.49	0.09	0	0.19	0.50
1894	8.51	7.50	0.05	0	0.53	0.43
1895	7.59	6.13	0.07	0	0.61	0.79
1896	11.54	8.90	0.06	0	1.98	0.60
1897	13.03	8.76	0.06	0.01	3.72	0.48
1898	12.90	10.37	0.05	0.03	2	0.45
1899	14.36	10.62	0.10	0.01	3.16	0.48
1900	21.55	16.53	0.11	0.03	4.43	0.44
1901	27.17	18.58	0.17	0	8.12	0.30
1902	31.80	22.05	0.18	0	9.06	0.52
1903	30.10	22.74	0.20	0	6.26	0.90
1904	28.64	21.11	0.17	0.40	6.18	0.77
1905	27.26	21.40	0.23	1.72	3.35	0.56
1906	31.32	19.49	0.22	1.63	9	0.98
1907	34.65	19.06	0.30	1.86	12.58	0.85
1908	42.30	24.39	0.23	2.29	14.67	0.73
1909	34.94	23.24	0.31	1.08	9.76	0.56
1910	33.47	19.03	0.33	2.41	10.72	0.98
1911	44.31	17.53	0.32	3.24	22.01	1.22
1912	63.14	28.62	0.56	6.07	26.40	1.50
1913	59.32	28.37	0.51	2.86	26.78	0.80
1914	54.98	30.09	0.50	6.33	16.73	1.33
1915	63.66	25.79	0.54	4.70	31.40	1.24
1916	69.75	29.74	0.49	7.24	29.83	2.44
1917	91.57	37.44	0.54	8.37	43.33	1.90
1918	102.05	35.21	0.59	13.83	50.03	2.39

Alaska Harvest Data (millions of fish), 1878-1998 (Continued)

Year	Total	SO	CH	CM	PN	CO
1919	57.37	16.51	0.97	11.68	25.77	2.46
1920	64.07	20.36	0.67	10.74	30.31	1.99
1921	38.58	26.21	0.66	2.72	7.90	1.09
1922	72.28	33.58	0.51	5.20	31.23	1.77
1923	78	26.97	0.94	4.92	43.45	1.72
1924	82.89	19.72	1.06	9.70	50.38	2.03
1925	64.72	15.58	0.84	10.81	35.48	2.02
1926	97.87	31.94	0.70	9.11	53.80	2.33
1927	48.24	17.44	0.91	5.18	21.89	2.81
1928	88.75	27.89	0.62	9.32	47.20	3.73
1929	71.95	20.45	0.80	8.68	39.85	2.18
1930	80.57	10.61	0.89	5.94	59.38	3.75
1931	70.45	21.38	0.64	5.78	40.62	2.02
1932	73.18	26.03	0.88	8.33	35.85	2.10
1933	80.67	32.03	0.61	7.08	38.97	1.98
1934	114.45	30.99	0.55	7.34	72.84	2.73
1935	71.84	10.45	0.77	8.44	49.88	2.30
1936	127.52	35.20	0.86	11.22	77.48	2.77
1937	109.74	31.93	1.06	8.39	66.34	2.02
1938	101.91	35.63	0.93	7.92	54.51	2.92
1939	79.28	25.39	0.80	7.33	44.18	1.58
1940	85.31	11.94	0.56	8.93	60.82	3.07
1941	104.28	14.92	0.84	6.59	77.90	4.04
1942	81.38	13.15	0.75	8.81	54.65	4.02
1943	87.67	27.68	0.66	9.60	47.30	2.44
1944	70.86	19.77	0.48	10.52	37.77	2.32
1945	75.60	15.35	0.62	8.24	47.83	3.55
1946	73.05	14.59	0.75	7.29	46.68	3.75
1947	70.79	26.69	0.76	6.31	34.49	2.55
1948	59	20.42	0.72	7.57	27.27	3.02
1949	78.69	12.12	0.73	5.75	57.06	3.03
1950	45.38	14.71	0.70	7.51	19.99	2.48
1951	49.99	9.87	0.84	6.74	28.46	4.09
1952	48.73	17.37	0.77	8.28	19.88	2.43
1953	37.50	11.97	0.75	7.45	15.71	1.61
1954	44.90	9.86	0.66	8.85	22.93	2.60
1955	40.06	8.93	0.64	3.74	24.86	1.90
1956	51.31	15.17	0.51	7.61	26.45	1.56
1957	34.89	10.15	0.58	8.73	13.77	1.67
1958	41.51	6.25	0.62	6.80	26.19	1.66
1959	25.65	8.29	0.68	4.28	10.95	1.47

Alaska Harvest Data (millions of fish), 1878-1998 (Continued)

Year	Total	SO	CH	CM	PN	CO
1960	43.64	18.34	0.62	7.09	16.13	1.46
1961	45.90	16.53	0.59	5.88	21.56	1.35
1962	63.62	9.52	0.54	7.43	44.02	2.11
1963	48.01	6.36	0.58	4.62	34.36	2.09
1964	66.79	10.22	0.95	7.56	45.41	2.65
1965	57.51	30.63	0.67	3.78	20.38	2.05
1966	64.87	15.47	0.62	6.62	40.19	1.99
1967	21.45	8.80	0.71	3.82	6.58	1.55
1968	63	8.32	0.71	6.24	44.88	2.86
1969	42.67	11.72	0.75	3.13	25.90	1.18
1970	69.49	27.87	0.75	8.10	31.19	1.57
1971	48.26	14.37	0.75	8.10	23.55	1.49
1972	32.63	6.76	0.64	7.38	15.98	1.88
1973	23.10	4.64	0.63	6.47	9.84	1.51
1974	23.06	5.16	0.63	5.36	9.95	1.96
1975	27.24	7.68	0.55	4.85	13.06	1.10
1976	45.41	11.97	0.65	6.43	24.86	1.50
1977	52.08	12.76	0.75	7.89	28.73	1.95
1978	83.64	18.42	0.96	7.20	54.08	2.99
1979	90.17	28.99	0.99	6.49	50.27	3.43
1980	111.77	33.65	0.86	10.36	63.57	3.33
1981	114.84	36.65	1	13.28	60.16	3.75
1982	113.45	29.24	1.04	11.78	65.09	6.31
1983	129.48	53.21	1.04	10.91	60.48	3.83
1984	135.37	38.76	0.86	13.70	76.43	5.62
1985	148.34	39.89	0.89	11.07	90.49	6
1986	130.57	32.59	0.84	13.04	77.45	6.64
1987	98.76	36.17	0.95	11.21	46.62	3.83
1988	102.61	30.57	0.84	15.80	50.53	4.88
1989	156.37	44.87	0.84	8.54	97	5.11
1990	157.05	53.29	0.94	8.44	88.46	5.92
1991	190.77	45.73	0.94	9.87	128.39	5.84
1992	138.50	59.11	0.90	11	60	7.49
1993	196.06	65.30	1.02	12.02	111.18	6.55
1994	198.24	52.92	1.26	16.97	116.95	10.15
1995	219.55	64.11	0.99	19.08	128.46	6.91
1996	176.58	50.28	0.74	21.25	98.08	6.23
1997	122.01	31.33	0.93	15.76	71.09	2.91
1998	153.11	23.01	0.85	19.28	105	4.97

Columbia River Harvest Data, 1866-1993

Year	CH	CO	SO	CM	ST	Total
1866	122.40	0	0	0	0	136
1867	550.80	0	0	0	0	612
1868	856.80	0	0	0	0	952
1869	3060	0	0	0	0	3400
1870	4590	0	0	0	0	5100
1871	6120	0	0	0	0	6800
1872	7650	0	0	0	0	8500
1873	7650	0	0	0	0	8500
1874	10710	0	0	0	0	11900
1875	11475	0	0	0	0	12750
1876	13770	0	0	0	0	15300
1877	11628	0	0	0	0	12920
1878	14076	0	0	0	0	15640
1879	14688	0	0	0	0	16320
1880	16218	0	0	0	0	18020
1881	16830	0	0	0	0	18700
1882	16563.80	0	0	0	0	18404.20
1883	19259.60	0	0	0	0	21399.60
1884	18972	0	0	0	0	21080
1885	16946.30	0	0	0	0	18829.20
1886	13724.10	0	0	0	0	15249
1887	10893.60	0	0	0	0	12104
1888	11397.80	0	0	0	0	12664.20
1889	8160.90	0	544.60	0	777	10536.10
1890	10269.50	0	1754.80	0	1310.40	14816.30
1891	10829.60	0	473.80	0	904.70	13564.40
1892	10534.60	127.80	2036.30	0	2213.90	16569.50
1893	8836.50	890.70	932	70.70	1995.90	14139.80
1894	10743.80	1308.40	1340.70	0	1604.10	16663.40
1895	13614.20	3047.80	551.30	688.30	1520.10	21579.70
1896	11350.80	1349.70	519.70	0	1519.70	16377.70
1897	13440.20	1862	396.90	0	1412.10	19012.50
1898	10431.20	2002.20	2040.10	0	804.10	16975.10
1899	8447	906	733.50	348.20	367	12001.80
1900	8660.30	1374.70	402.80	541.50	630.30	12899.50
1901						14916.20
1902	10365.20	322.30	521.30	318.30	262.90	13100
1903	12562.80	372.70	256.50	306	221.90	15244.40
1904	14302.10	956.40	395.10	633.20	302	18432
1905	14862.90	820.90	237.70	788	300.60	18900.10
1906	13486.80	1268.20	239.20	850.70	198.90	17826.60

Columbia River Harvest Data, 1866-1993 (Continued)

Year	CH	CO	SO	CM	ST	Total
1907	10912.70	971.80	168.40	690.20	181.20	14360.30
1908	8884.10	961.80	262.60	516.60	328.20	12170.50
1909	7703.50	1290.60	766.90	751	528.80	12267.70
1910	11396.50	2109	190.80	2036.10	166.30	17665.20
1911	16470.90	2430.10	183.20	1636.20	263	24740
1912	9624.60	0.10	251.20	572.20	966.20	13765.10
1913	8723	1253.70	341.20	407.10	975.60	13278.10
1914	11434.10	2134.90	1080.50	1508.10	858.40	19250.70
1915	14457.10	1020.10	167	2647.80	1210.60	21919.40
1916	14396.80	1593.80	116	2379.60	711.40	21373.20
1917	13284.90	0.10	243.80	1642	1004.90	20224
1918	13162.10	3003.30	1157.70	913.30	1360.20	22062.70
1919	13646.40	2776.30	222.40	2310.10	855	22467.30
1920	13992.40	826.90	80.10	575.10	524.70	18155.80
1921	9698.30	1052.10	185	147.50	459.50	13356.30
1922	8061.60	2767.40	940.70	270.60	973.30	15076.40
1923	9710.20	3134.30	1172.30	780.50	1207.90	17833.70
1924	10064.30	3508.40	225.40	1767.10	1436.80	19083.60
1925	11997	3571.50	172.90	1707.80	1308.20	21166.70
1926	9558.50	2972.60	665.10	1005.30	1729.40	17783.40
1927	10804.80	2344.30	183.70	2094.50	1416.30	18844.20
1928	8167.20	1675.30	147.30	3823.60	972	16563.60
1929	8168	3015.50	308.20	1671.30	1291.50	16160.70
1930	9035.40	3481.60	300.60	347.90	1081.80	15961.70
1931	9620.30	1221.40	126.20	107.60	956.70	13515.90
1932	7200.40	1843.40	85.50	528.20	644.30	11665.10
1933	8787.80	1215.70	211.80	746.60	881.20	13423.40
1934	8454.40	2148.60	210.20	748.30	863.60	13951
1935	6869.90	3198.70	39.80	474.20	662.50	12878
1936	7296.10	1123.10	301	936.30	873.40	11764.30
1937	8394.10	828.70	150.80	859.40	870	12336.80
1938	5588.30	1040	191.10	861.90	794	9417
1939	6074.50	688.40	121.40	528.50	647.30	8955.60
1940	6082.20	617.90	162.90	564.10	1266.90	9660.10
1941	10457.30	470.30	227.60	1867.40	1198.70	15801.40
1942	8405.60	290	86.60	2336	827.60	13273.10
1943	5141.90	317.80	65.70	432	681.50	7376.70
1944	6326.80	690	24.70	123.90	774	8821.60
1945	5837.40	826	3.90	265	883.60	8684.30
1946	6425	476.80	57.80	399	776.50	9039.10
1947	7786.20	674.10	323.20	223.30	741.90	10832

Columbia River Harvest Data, 1866-1993 (Continued)

Year	CH	CO	SO	CM	ST	Total
1948	7808.50	528.60	43.10	470.20	710.60	10623.30
1949	4845.80	404.60	10.80	245.30	366.30	6525.40
1950	4689.80	471.60	76.10	315.10	425.30	6642.20
1951	4516.30	435.60	76.20	239.50	543.20	6456.60
1952	3272	483.30	273.90	138.90	657.90	5362.20
1953	3135	205.90	65.80	112.10	854.20	4858.90
1954	2390.70	136.50	109.50	144	652.90	3815.20
1955	3861.90	269.50	90.20	56.50	594	5413.40
1956	3680.30	207	129.20	20.60	366.80	4893.20
1957	2663.50	175.80	108.10	14.40	333.50	3661.50
1958	2895.30	75.40	325.60	40.20	315	4057.20
1959	2067.40	53.90	286.10	19.30	282.80	3010.60
1960	1767.60	71.60	177.30	6.90	295.80	2577
1961	1872.10	172.20	71.10	7.80	275.50	2665.20
1962	2460.30	270	23.30	21.60	321.90	3441.20
1963	1955.70	225.50	22	6.90	437.80	2942.10
1964	2017.80	883.60	30.70	10.80	189.50	3480.30
1965	2764.30	855.80	10.30	2.70	229.50	4291.90
1966	1625.50	1975.10	7.70	5	176.90	4211.30
1967	2238.30	1718.10	87.80	4.40	200.50	4721.20
1968	1843.70	433	40.30	1.50	195.30	2793.10
1969	2599.20	748.50	47	1.80	222.80	4021.40
1970	2907.80	2585.50	25.10	3.60	140.30	6291.40
1971	2685.20	1025.10	128.50	2.70	210.40	4502.10
1972	2558.10	557.70	124	7.20	300.20	3941.40
1973	3848.60	857.20	7.20	8.10	285.30	5562.60
1974	1637	1094.70	0.10	4.80	83.30	3133.30
1975	2963.90	711.60	0	2.60	31.30	4121.60
1976	2514	597.90	0.20	7.60	39	3509.70
1977	2109.80	142.50	0.20	1	191.60	2716.80
1978	1653.50	493.60	0	9.20	112.10	2520.50
1979	1451.80	493.60		0.70	30.90	2196.70
1980	1382.50	505.10		1.40	29.50	2131.80
1981	782.70	212.90		8.30	44.10	1164.60
1982	1366.20	720.10	0.20	10	43.40	2377.80
1983	467.50	20.40	2.90	0.90	70.50	624.80
1984	931.10	729.60	49.70	9.90	408.80	2365.70
1985	1191	753.60	129.30	3.40	344.80	2691.30
1986	2128.10	3069	10.70	9.10	307.70	6138.50
1987	4057.60	591	115.40	6.30	339.20	5677.40
1988	4742.60	1207.60	81.50	13.60	344.20	7099.40

Columbia River Harvest Data, 1866-1993 (Continued)

Year	CH	CO	SO	CM	ST	Total
1989	2754.10	1207.40	0	7.80	266	4705.90
1990	1392.90	225.50		4.20	149	1968.50
1991	897.50	1228.60		1.90	138.30	2518.20
1992	428.50	136.70		3.10	209.30	864.10
1993	395	122.10		0.20	118.40	706.40

American Northwest Harvest (millions of fish), 1867-1998

Year	SO	PI	CM	CO	CH	Total
1867					0.07	0.07
1868					0.11	0.11
1869					0.40	0.40
1870					0.61	0.61
1871					0.81	0.81
1872					1.01	1.01
1873					1.01	1.01
1874					1.42	1.42
1875					1.53	1.53
1876					1.86	1.86
1877					1.66	1.66
1878					2.05	2.05
1879					1.99	1.99
1880					2.44	2.44
1881					2.95	2.95
1882				0.05	2.99	3.04
1883				2e-3	3.10	3.10
1884				0.01	2.89	2.90
1885				0	2.63	2.63
1886				0	2.02	2.02
1887				0	1.58	1.58
1888				0	1.81	1.81
1889	0.32	0.06	0.04	0.87	1.13	2.42
1890	1.04	0	0.09	0.45	1.13	2.71
1891	0.35	0.13	0.10	0.41	1.12	2.12
1892	1.25	0	0.32	0.72	1.11	3.41
1893	1.18	0.24	0.25	0.64	1.01	3.33
1894	1.34	0	0.27	0.81	1.24	3.66
1895	1.18	0.40	0.74	1.79	1.47	5.57
1896	1.26	0	0.30	1.26	1.39	4.22
1897	4.31	0.80	0.25	1.38	1.63	8.36
1898	4.50	0	0.36	1.49	1.31	7.66
1899	6.96	3.56	0.64	2.11	1.21	14.47
1900	3.24	0	0.97	1.36	1.18	6.74
1901	14.09	0	0.57	1	0.84	16.49
1902	4.31	0	1.20	0.94	1.49	7.94
1903	2.06	2.52	0.20	1.03	1.74	7.56
1904	1.74	0	0.85	1.52	2.12	6.23
1905	10.47	0.99	0.75	1.03	2.16	15.40
1906	2.17	0	1.52	1.43	1.81	6.93
1907	1.13	6.03	0.64	1.47	1.71	10.97

American Northwest Harvest (millions of fish), 1867-1998 (Continued)

Year	SO	PI	CM	CO	CH	Total
1908	2.04	0	0.66	1.54	1.52	5.75
1909	14.12	5.16	0.73	1.60	1.48	23.08
1910	2.88	0	1.89	2.18	1.99	8.94
1911	1.56	14.71	1.66	3.08	2.43	23.45
1912	2.16	0	0.90	1.85	1.88	6.78
1913	21.94	15.95	0.72	0.98	1.73	41.32
1914	4.10	0.08	2.87	2.12	1.85	11.02
1915	0.84	7.41	4.20	1.82	2.07	16.33
1916	0.98	0.08	5.39	2.03	2.13	10.61
1917	5.15	13.38	2.32	1.52	1.98	24.36
1918	1.26	0.09	2.39	2.79	1.96	8.48
1919	0.91	4.67	5.06	2.30	2.23	15.17
1920	0.73	0.02	0.52	0.39	1.94	3.59
1921	1.31	4.41	0.28	0.68	1.58	8.27
1922	1.07	0.03	0.62	1.68	1.64	5.04
1923	1.19	5.53	1	2	1.94	11.67
1924	0.91	0.10	1.52	2.38	2.32	7.23
1925	1.27	6.67	1.01	2.26	2.65	13.86
1926	0.54	0.02	1.26	1.93	2.03	5.78
1927	1.02	6.53	1.03	2.07	2.19	12.83
1928	0.64	0.01	1.64	1.56	1.58	5.42
1929	1.31	7.43	1.93	1.76	1.61	14.05
1930	3.29	0.02	1.17	1.73	1.75	7.95
1931	0.74	8.13	0.89	1.27	1.77	12.80
1932	0.83	0.01	1.34	1.45	1.50	5.14
1933	1.61	6.04	0.63	1.31	1.70	11.30
1934	2.69	0.01	1.06	1.44	1.62	6.82
1935	0.72	5.83	0.84	3.43	1.72	12.54
1936	0.53	0.03	1.04	1.74	1.84	5.17
1937	1	5.09	0.98	1.95	2.04	11.06
1938	1.57	0.01	1.01	1.41	1.32	5.31
1939	0.59	4.07	0.44	1.76	1.28	8.15
1940	0.99	0.03	0.74	1.65	1.78	5.19
1941	2.15	2.02	1.18	1.74	2.05	9.15
1942	3.11	2e-3	1.20	0.87	1.97	7.15
1943	0.29	0.97	0.56	1.15	1.57	4.54
1944	0.38	4e-3	0.40	1.16	2.02	3.97
1945	0.79	5.91	0.52	1.61	2.39	11.22
1946	3.63	0	1.51	1.09	2.65	8.88
1947	0.29	9.39	0.71	2.18	2.50	15.06
1948	1.18	0	1.10	1.77	2.03	6.08

American Northwest Harvest (millions of fish), 1867-1998 (Continued)

Year	SO	PI	CM	CO	CH	Total
1949	1.31	7.69	0.54	1.78	1.70	13.01
1950	1.36	0.01	1.09	1.90	1.79	6.15
1951	1.22	5.70	1.04	1.97	2.04	11.97
1952	1.18	2e-3	0.93	2.69	2.10	6.90
1953	2.07	6.13	0.51	1.91	1.98	12.60
1954	4.94	0	0.74	1.34	2.17	9.19
1955	1.12	5.30	0.38	1.71	2.76	11.26
1956	1.07	1e-3	0.20	2.44	2.69	6.40
1957	1.75	3.27	0.21	2.24	2.01	9.48
1958	5.34	0.01	0.56	1.58	1.59	9.08
1959	1.89	2.66	0.52	1.61	1.55	8.23
1960	1.26	2e-3	0.21	0.69	1.50	3.66
1961	1.43	0.79	0.17	1.86	1.85	6.10
1962	0.78	0.01	0.24	2.05	1.63	4.70
1963	1.41	6.73	0.32	2.12	1.90	12.48
1964	0.54	0.01	0.29	2.66	1.83	5.32
1965	1.05	0.77	0.21	3.51	1.77	7.31
1966	1.40	0.03	0.43	3.84	1.63	7.33
1967	2.16	4.17	0.29	3.95	1.46	12.03
1968	0.99	0.01	0.48	3.48	1.67	6.63
1969	1.67	1.03	0.20	2.66	1.93	7.49
1970	1.37	0.01	0.27	4.33	2.08	8.07
1971	3.13	2.54	0.18	5.36	2.03	13.24
1972	1.23	4e-3	0.90	3.30	2.05	7.48
1973	2.69	2.43	0.61	3.84	2.99	12.57
1974	2.51	1e-3	0.46	5.32	2.27	10.57
1975	1.69	1.43	0.22	3.83	2.55	9.72
1976	1.33	2e-3	0.82	6.59	2.30	11.05
1977	1.89	2.38	0.47	3.21	2.53	10.47
1978	1.40	4e-3	1.30	3.47	1.95	8.12
1979	1.80	4.81	0.13	3.33	2.11	12.18
1980	0.60	2e-3	1.02	3.16	1.88	6.66
1981	1.33	4.18	0.54	2.67	1.71	10.44
1982	2.90	0	1.12	3.14	2.09	9.24
1983	0.43	1.97	0.56	2.10	1.11	6.17
1984	1.76	0	0.78	1.69	1.20	5.43
1985	3	4.34	1.19	2.32	1.50	12.34
1986	2.76	0	1.29	4.08	2.33	10.46
1987	2.01	2.14	1.44	3.35	2.90	11.83
1988	0.97	0	1.85	3.20	3.33	9.36
1989	2.26	3.52	0.93	2.97	2.17	11.84

American Northwest Harvest (millions of fish), 1867-1998 (Continued)

Year	SO	PI	CM	CO	CH	Total
1990	2.19	0	1.12	2.46	1.75	7.52
1991	1.85	3.40	1.11	2.99	1.14	10.49
1992	0.63	0	1.54	1.28	1	4.45
1993	2.74	2.21	1.18	0.80	1.07	7.99
1994	1.85	0	1.44	0.62	0.75	4.65
1995	0.42	2.96	0.78	0.68	1.75	6.59
1996	0.34	0.13	0.82	0.56	1.32	3.16
1997	1.37	1.98	0.66	0.28	1.37	5.66
1998	0.54	8.67e-4	0.79	0.35	0.84	2.53