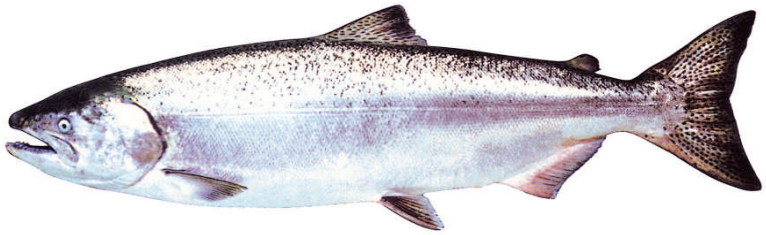
North Pacific Salmon Fisheries Economic Measurement Estimates



Chinook *(Oncorhynchus tshawytscha)*

Chum *(Oncorhynchus keta)*

Coho *(Oncorhynchus kisutch)*

Pink *(Oncorhynchus gorbuscha)*

Sockeye *(Oncorhynchus nerka)*

Cherry *(Oncorhynchus masou)*

Notes: Depicted fish size relational to each other is correct for average North Pacific harvests.
Sources: Photos courtesy of BC Salmon Marketing Council and FishPix (cherry photo by T. Suzuki KPM-NR0000085).

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This report was reviewed in draft form for the purpose of providing candid and critical comments that were to assist in making study results as sound as possible and to ensure that the report meets standards for objectivity, evidence, and responsiveness to the study charges. Although the reviewers have provided many useful comments and suggestions, they were not asked to endorse study findings and recommendations. The authors are solely responsible for making certain independent examination of this report was carried out in accordance with accustomed procedures and that review comments were carefully considered.

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LIST OF ACRONYMS AND ABBREVIATIONS

CWT	coded wire tag
EEZ	exclusive economic zone
FAO	Food and Agriculture Organization of the United Nations
IUU	illegal, unreported, and unregulated catch
MALBEC	Model for Assessing Links Between Ecosystems
NPAFC	North Pacific Anadromous Fish Commission
SAFE	Select Area Fishery Enhancement
SAR	smolt-to-adult return rate
SAUP	Sea Around Us Project
TRG	The Research Group
WSC	Wild Salmon Center

NORTH PACIFIC SALMON FISHERIES ECONOMIC MEASUREMENT ESTIMATES

EXECUTIVE SUMMARY

The Wild Salmon Center desired desk level, first order estimates for North Pacific commercial salmon fisheries economic measures. The measures were to include direct effects (fish numbers, volume, and harvest/first wholesale value) and were to include comparable indicators so that the importance of salmon fishing industry could be shown within regional economies. The proportional share of the effects from salmon origin (natural or hatchery) was also of interest. These measurements are not universally available for all fisheries and it was necessary to use proxy modeling, scale-up methods, and impute information to fill gaps in limited spatial and temporal measurements to represent area-wide estimates.

Value at the harvest level (ex-vessel value) was a particularly vexing statistic to procure. It was necessary to use Alaska reported ex-vessel prices to fill gaps. This is a reasonable approach because fish products are exchanged in world markets and the U.S. is a major producer as well as export/import trader. (Alaska dominates U.S. salmon production.) World market price determination factors are going to be reflected in U.S. seafood trading prices. Also, it was not possible to develop economic regional impact models for the investigation. Instead, a model for Alaska was used to proxy effects in other countries. Using Alaska fishing industry modeling is apropos because many similar harvest species, fishing techniques, seafood product mix, and destination markets are the same for other North Pacific countries.

Enhancement of salmonid species natural production using artificial propagation takes place in all regions of the North Pacific. In some areas, such as the Columbia River, public hatcheries are part of mitigation agreements for dam construction and habitat alterations. In other areas such as Alaska, hatcheries are a public/private partnership designed to increase natural production. In the Russian Far East, both private and public hatcheries have been developed to increase overall harvests. Based on the limited amount of information available, in many cases the revenues that may be received from these harvests are not adequate to cover the costs of producing fry/smolts. Fishery enhancement hatcheries are often the political response to societal demands for increasing salmon and steelhead harvests or replacing production lost to other manmade water developments; and, economic analysis rarely plays a role in decision making for that response.

Study area salmonid abundance by origin estimates show that hatcheries contribute significantly to North Pacific capture fisheries using the assumption that ocean harvests are not appreciably selective. Hatchery production varies considerably by region and species. Less than 10 percent of total salmon production in Russia originated from hatcheries, but hatchery production has been increasing in recent years. Hatchery salmon represented more than 70 percent of both total pink salmon and total chum salmon in Prince William Sound, and more than 55 percent of chum salmon in southeast Alaska. Nearly all of Japan's production is from hatchery origin chum salmon. Using a 1990-2005 annual average, hatchery-origin adult salmon abundance averaged 78 million chum, 54 million pink, and 3.2 million sockeye salmon per year, or approximately 62 percent, 13 percent, and four percent, respectively, of the combined total of wild and hatchery salmon abundance.

The average annual catch of anadromous fish in the North Pacific between 2003 and 2007 is 432 million fish. Catches in 2007 (preliminary estimates of 511 million fish) were the highest on record. Largest catches were reported by Alaska (213 million fish), Russia (213 million fish), and Japan (76 million fish). Pink and chum salmon constituted the majority of the catch (68 percent and 19 percent by fish numbers, respectively), sockeye salmon were 12 percent, while coho and Chinook salmon were 1.0 and 0.2 percent, respectively. Pink salmon catches were considerably higher than recent years, sockeye and chum salmon catches were similar to the means, while Chinook and coho salmon catches were lower.

The total ex-vessel value from the commercial fisheries in 2007 is estimated to be $USD 818 million and the value at the first wholesale level is estimated to be $USD 2.2 billion. Of the total $USD 3.0 billion personal income generated from the salmon fishing industry in 2007, 43 percent was in the U.S., 32 percent in Russia, and 23 percent in Japan. The other Pacific salmon countries of Canada and Korea had two percent of the summed economic contribution. Harvesting and processing jobs are estimated to be an equivalent 35 thousand in 2007 in the North Pacific countries.

Several recent studies have investigated illegal, unreported, and unregulated catch (IUU). For example, estimates IUU in the Kamchatka region means reported harvests should be increased by a factor of 1.5 to 2.0 to represent total catch. All of the studies recommend a careful approach to resolving reporting because harvests do contribute to local economies. The importance for resolution is to make sure the catch counts are included in sustainable fishery management practices.

The study recommends specific detailed data and economic analysis tasks to resolve missing data issues and economic measurement uncertainties. Despite the uncertainties, there can be useful outcomes for making qualified estimates. Pulling together explanations of measurement units provides instructional information. And focusing efforts to overcome unknowns and uncertainties will lead to more realistic estimates in successive investigations.

A. Background

The Wild Salmon Center (WSC) desired desk level, first order estimates for North Pacific Ocean commercial salmon fisheries economic measures.[1] The measures were to include direct effects (fish numbers, volume, and harvest/first wholesale value) and were to include comparable indicators so that the importance of salmon fishing industry could be shown within regional economies. The proportional share of the effects from salmon origin (natural or hatchery) was also of interest. Where existing studies and datasets did not exist, proxy information was to be used to complete the assessments.[2] Key areas of uncertainty for the estimates were to be discussed and recommendations for further research were to be made.[3]

It was realized that underlying problems in data and information available about harvest and processing activities as well as regional economies would contribute to imperfect estimates. Finding dependable relationships to model, scale-up, or impute information to fill gaps in limited spatial and temporal measurements to represent area-wide

estimates could be questioned. Still, there can be useful outcomes for undertaking such assessments. Pulling together explanations of measurement units provides instructional information. Providing qualified estimates can be a starting point for future estimation correction. And focusing efforts to overcome unknowns and uncertainties will lead to more realistic estimates in successive investigations.

B. Harvest and Abundance Data Sources

The North Pacific Ocean area is defined for the study to be inclusive of the harvesting reported by the United States, Canada, Russia, Japan, China, and the Koreas. Thus the harvested fish origins should be encompassed in the ecosystems defined by Augerot (2005) for the term "Pacific salmon."[4] The defined area has the data advantage of being coincident with the Convention Area for the North Pacific Anadromous Fish Commission (NPAFC).[5] The NPAFC through its science and enforcement programs provide catch, fishery enhancement and other technical information pertaining to areas from which anadromous stocks migrate into the Convention Area.[6]

The United Nations Food and Agriculture Organization (FAO) provides software (named FishStat+) and databases that contain estimates by country and species for capture and aquaculture production. The database includes fishery product volume and value; and, countries' import and exports volume and value. The NPAFC data is generally consistent with the FAO databases, but recent year data is usually available sooner from NPAFC.

Neither the FAO nor the NPAFC provide the harvest value of capture fisheries. Sumaila et al. (2005) describes an attempt to create a global ex-vessel fish price database.[7] It was found that price information is widely scattered and incomplete. The authors devised a rule-based decision process to fill gaps using U.S. reported ex-vessel prices. This is a reasonable approach because fish products are exchanged in world markets and the U.S. is a major producer as well as export/import trader. Except for isolated examples, product market value is going to be reflected in prices paid at the fisherman level.

Based on Sumaila et al. (2005), it was decided to use Alaska reported prices to fill gaps in other North Pacific harvest reporting. Alaska capture salmon fisheries dominate the U.S. capture production. Except for local and niche markets, the Alaska production is a direct substitute for any U.S. West Coast capture fishery product. The reliance on U.S. prices to estimate salmon harvest value for North Pacific countries is further justified because Japan is the major seafood consumer nation and the U.S. is the highest producer nation of the North Pacific countries.[8] Alaska fisheries price trends are shown on Figure 6.

Pacific salmon abundances (adult harvests plus freshwater escapements) are a modeled measurement. Of recent research about salmon abundances, the MALBEC Project (Mantua et al. 2007) is a comprehensive and thorough investigation. The Project relies on observed data and scaling to determine actual abundance trends in the North Pacific between 1952 and 2000.[9] A density dependent model was developed to forecast abundances for chum, sockeye, and pink salmon for the period 2007-2050.[10] The model was based on specified changes in the carrying capacity or productivity for marine

or freshwater habitat or both due to human or natural causes.

The MALBEC Project reports are especially useful because the itemization can be interpreted to be harvest stock contributions from natural and hatchery origin. Most North Pacific ocean salmon fisheries do not have origin select harvesting so that derived estimates for abundance origin proportions can be assumed to approximate harvest proportions.[11]

C. Economic Measurements and Models

Economic measurements used in this study are both from secondary sources and modeled. Harvest statistics are generally available in physical units (numbers of fish and weight) and sometimes available in value units (harvest level prices), however there is only a scattering of economic measurements available from North Pacific countries. Prices paid at the fisherman level are readily available for U.S. fisheries, but not in other North Pacific countries. Ex-processor sale prices for capture fisheries are not regularly reported for all countries. Alaska processing businesses must report the first wholesale value of their products, but other U.S. states do not require this reporting. The cost to operate hatcheries and the cost for management and enforcement is sometimes available (Radtke 2009). It was necessary to use assumptions (see Table 2) and scaling factors to complete measurement estimation.

The economic modeled measurements include the regional economic contributions made from business activities associated with the commercial salmon fishing industry. Regional economic contribution units include the amount of household income generated in a defined region through the activities of the economic venture analyzed. Within the salmon fishing industry, income generation can be associated with hatchery programs, as well as the harvesting and processing of salmon. The contributions would include the direct earnings generated for participants in hatchery programs and harvesting/processing. Contributions also include indirect earnings resulting from labor requirements at supporting industries in the region. Finally, the income includes induced earnings from money re-spent in regions. The summation of direct, indirect, and induced is sometimes referred to a the multiplier effect of an industry.

It was not possible to develop or even compile and scale economic regional impact models for this investigation. Instead, a model for Alaska was used to proxy effects in other countries. The Alaska FEAM model developed by William Jensen and Hans Radtke was utilized. The model description is aptly described by Seung and Waters (2006). Hans Radtke provided the Alaska FEAM relationships.[12]

Using Alaska fishing industry modeling is apropos because many similar harvest species, fishing techniques, seafood product mix, and destination markets are the same for other North Pacific countries. The Sinyakov (2005) economic model outputs were reviewed for consistency with the Alaska FEAM adaptations for harvesting and processing in Russia. The Japan fishing industry socio-economic characterization provided by Carl-Christian Schmidt (2003) and Japan Fisheries Agency (2008) were useful for cross checking applicability of the Alaska FEAM to the Japan economy.

Another modeled economic measurement unit is added value jobs. It is a calculated

unit based on the labor burden and average annual full time income received from participants in the fishing industry. The job measurements assumed a $25,000 earnings ratio for both the harvesting and processing sector. Job counts for the harvesting sector include owners skippers, crew members; and for the processing sector include management and line workers.[13] The use of job equivalent counts is necessary because of an enumeration issue for fishing industry occupations. Capture salmon fisheries are seasonal and the same workers who participate in salmon fisheries harvest and processing sectors will also participate in other fisheries. Employment reporting from countries (when available) does not usually refine or associate worker counts with particular fisheries.

The quantities calculated were:

$$H_j = P_j \cdot V_{ij}$$
$$S_j = M_j \cdot Y_{kj} \cdot H_j$$
$$F_j = F_j \cdot S_j$$
$$B_j = L_j \cdot S_j$$
$$F_j = H_j \cdot E_j$$

with i = countries
j = species
k = product forms
V = harvest volume (round pounds)
S = processor volume (finish pounds)
Y = yields for product forms
P = harvest prices ($USD)
F = first wholesale prices ($USD)
M = product mix (percent finish pound)
H = ex-vessel value ($USD)
W = ex-processor value ($USD)
L = labor cost ($USD per finish pound)
B = labor cost ($USD)
E = economic contribution ($USD personal income per $USD ex-vessel value)
F = economic contribution (personal income $USD)

D. Economic Measurement Estimates

1. Harvests

The average annual catch of anadromous fish by the NPAFC member countries between 2003 and 2007 is 432 million fish. Catches in 2007 (preliminary estimates of 511 million fish) were the highest on record (Table 1). In 2007, largest catches were reported by Alaska (213 million fish), Russia (213 million fish), and Japan (76 million fish). In 2007, pink and chum salmon constituted the majority of the catch (68 percent and 19 percent by fish numbers, respectively), sockeye salmon were 12 percent, while coho and Chinook salmon were 1.0 and 0.2 percent, respectively (Table 1). Pink salmon catches were considerably higher than recent years, sockeye and chum salmon catches were similar to the means, while Chinook and coho salmon catches were lower.

2. Economic Value

The total ex-vessel value from the commercial fisheries in 2007 is estimated to be $USD 818 million (Table 1). The first wholesale value in 2007 is estimated to be $USD 2.2 billion. Harvesting and processing jobs are estimated to be 35 thousand in 2007. Of the total $USD 3.0 billion personal income generated from the salmon fishing industry in 2007, 43 percent was in the U.S., 32 percent in Russia, and 23 percent in Japan. The other Pacific salmon countries of Canada and Korea had two percent of the summed economic contribution (Figure 5).

3. Markets

Salmon is a commodity exchanged worldwide. In recent years, capture salmon only represents about 40 percent of worldwide production, with farmed salmon production overtaking the market share in about 1997 (see Appendix Table A-2). Aquaculture products are readily available in an integrated market and compete with any products from capture production.[14] This has forced capture fishery production prices into a "take" position with aquaculture production prices (see Figure 8).[15]

Norway and Chile dominate production at 77 percent (Asche and Tveterås 2008). Atlantic salmon is the preferred aquaculture salmon species, followed by coho [one-tenth of aquaculture production in recent years according to Asche and Tveterås (2008)]. The average price of aquaculture Atlantic salmon in 2006 was only about 25 percent of what was received in 1985. Technology and distribution logistics has largely been responsible for the reduction. As labor and capital costs have been reduced, feed cost burden as a proportion have risen, accounting for 52 percent in 2004. Capture fisheries still enjoy niche markets where concerns about aquaculture quality is a consideration.

North Pacific capture harvests enter the wholesale market in a variety of forms (see Table 2 for study model assumptions and the appendix for import/export product forms). For example, Alaska sockeye is nearly all exported to Japan as frozen and the majority of Alaska pink salmon is mostly canned and sold in U.S. markets. Russia also supplies Japan a large share of their salmon in fresh and frozen product forms. The Japan fresh and frozen market is the second largest market in the world. The Europe market is the largest, but it is supplied from aquaculture while Japan's is supplied both from capture and aquaculture production.

The economic challenges facing the capture salmon fishing industry include:

- Global economic conditions,
- Price resistance,
- Seasonality,
- Consistency of supply and resulting price fluctuations,
- Higher fuel and transportation costs,
- Proliferation of eco-labeling schemes, and
- Lower prices of competing proteins, including farmed fish, and well-funded campaigns promoting other proteins.

The success for increasing the added value from capture fisheries will depend on being able to distinguish products in mass salmon markets.

E. Illegal, Unreported, and Unregulated Catch

Several recent studies have investigated illegal, unreported, and unregulated catch (IUU). Dronova and Spiridonov (2008) report that harvests in the Kamchatka region should be increased by a factor of 1.5 to 2.0 to represent total catch. For example, if Russian capture harvests were multiplied by two in 2007, then total North Pacific capture would increase by 34 percent. Clarke (2007) itemizes the IUU catch that makes its way to Japanese, U.S., and other world markets. Additional work by Clarke et al. (2009) found actual harvests were 60 to 90 percent higher than reported harvests. It uses a harvest and export/import balancing method to determine the amount of IUU. Tinch et al. (2008) reports on IUU from capture and consumption in Europe. The

SFM (2008) investigates IUU salmon and all other species harvests in the Asia-Pacific. All of these studies recommend a careful approach to resolving reporting because harvests do contribute to local economies. The importance for resolution is to make sure the catch counts are included in sustainable fishery management practices.

The NPAFC has continued pressure on member countries to eliminate IUU catch. The NPAFC coordinates boat patrols and aerial surveys by member countries to enforce the prohibition of high seas directed fisheries for anadromous fish species. The United Nations FAO on November 22, 2009, adopted and opened for signature the "Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing." The Agreement is specifically designed to address IUU fishing through actions by port States.[16] The U.S. is considering legislation to reduce the problem through H.R. 1080: Illegal, Unreported, and Unregulated Fishing Enforcement Act of 2009.[17] The act would modify existing statutes and authorize additional enforcement measures relating to search or inspection of facilities or conveyances, records inspection, shipment detention, arrest, search and seizure, and service of civil or criminal processes.

F. Hatchery Production

Study area abundance by origin estimates from the MALBEC Project data show that hatcheries contribute significantly to overall abundance in some regions (Figure 1). Less than 10 percent of total salmon production in Russia originated from hatcheries, but hatchery production has been increasing in recent years (Radtke et al. 2009). Hatchery salmon represented more than 70 percent of both total pink salmon and total chum salmon in Prince William Sound, and more than 55 percent of chum salmon in southeast Alaska. Nearly all of Japan's production is from hatchery origin chum salmon.[18] During 1990-2005, hatchery-origin adult salmon abundance averaged 78 million chum, 54 million pink, and 3.2 million sockeye salmon per year, or approximately 62 percent, 13 percent, and four percent, respectively, of the combined total of wild and hatchery salmon abundance. Knapp et al. (2007) reports recent years hatchery origin harvest proportions in Alaska to be about 38 percent of total capture salmon fisheries, including about 40 percent of pink and 69 percent of chum salmon catches.

The economic influence of hatchery versus natural origin contribution to capture fisheries markets has not received significant research. Ex-vessel prices can be influenced by the timing and volume of catch. Terminal salmon fisheries (such as the Alaska cost-recovery fisheries) can shock the amount of catch available to processors and lead to downward price pressures. Generally market promotion efforts emphasize "wild" caught salmon which can include hatchery and natural origin. Some marketing campaigns for niche markets (for example Copper River salmon) will mention the fish origin is from natural spawning. The concern is that market information about hatchery operations will undermine consumer perception about the premium quality from wild capture as compared to aquaculture products.

Some research work has been accomplished on the cost and benefits from hatchery production. Radtke (2009) provides a review of Russian, Alaskan, and Columbia River hatcheries that are operated for fishery enhancement purposes. The conclusion of this and other reviews is that harvest value

received is highly influenced by ocean conditions that determined adult survival, and that in most years, hatchery production and capital costs exceed harvest benefits.

Radtke (2009) found the cost of hatchery released smolts fits three general production categories:

- Hatchery operation costs. This category includes the primary hatchery plus other hatcheries where the fish might be taken for rearing and liberation.
- Agency headquarters costs. These costs are calculated as an indirect accounting rate on some hatchery costs.
- Capital or fixed costs. These costs are not typically included in annual budgets showing hatchery operation costs. It is usually necessary to use other studies or methods to estimate construction and upgrade costs.

Radtke (2009) made the following general hatchery cost analysis observations about production costs.

- Size at release will vary from less than one gram (454 fry per pound) to 45 grams (10 smolts per pound).
- Releases are generally described as "river fish" (spring/summer Chinook or coho) or "ocean fish" (pink or chums). Sockeye are generally released into fresh water systems (including lakes) before they migrate into the ocean.
- The river fish are generally released after 18 months in the hatchery system at around 20 to 45 grams per release. The ocean fish are generally released after about six to eight months in the hatchery system at around one to two grams per release. Fall Chinook are generally lower river spawners that are kept in the hatchery system about nine to 12 months to reach a size of 30 to 100 grams at release.
- Production costs vary with the species and size at release.
- Labor costs are generally the largest component of total variable costs and feed costs for ocean fish are not a large component of the total variable cost. The reverse is true for aquaculture raised fish.
- Capital costs are generally not included in annual budgeting processes.

The indicator for the share of hatchery reared smolts that escape natural mortality and are either harvested or return to hatcheries is usually called smolt-to-adult return rate (SAR's). Expected SAR's compared to actual rates are an important component in hatchery policy and management decisions.[19] SAR's vary by species, by area of release, and by freshwater and ocean conditions.[20] Past experience can be an indicator of expected SAR's of released fry or smolts. SAR's have been as low as 0.001 for upper Columbia Basin released fish, or 0.0003 for Kamchatka area chum releases, to as high as 0.10 in some Alaska coho programs.

Each hatchery program will have a minimum SAR necessary to show whether the program's benefits exceed the costs. (The benefit measure can be summed harvest value or summed society economic value when the costs are a commensurate production measurement. Annualized capital costs should be included in any benefit and cost analysis.) Carter (1999) found that hatcheries operated by the Oregon Department of Fish and Wildlife seldom have SAR's that generate a society

level positive benefit to cost relationship. The same was found by other investigators for Alaska (Boyce et al. 1993) and British Columbia (Pearse 1994) hatchery programs.

Enhancement of salmonid species using artificial propagation takes place in all regions of the North Pacific. In some areas, such as the Columbia River, public hatcheries are part of mitigation agreements for dam construction and habitat alterations. In other areas such as Alaska, hatcheries are a public/private partnership designed to increase natural production. In the Russian Far East, both private and public hatcheries have been developed to increase overall harvests of salmonids. Total hatchery production releases in 2006 were 4.8 billion (Table 3).

Hatcheries have been referred to as a foolish bargain (Walters 1996), but Heard (undated) and Smoker and Linley (1997) argue that the Alaska Prince William Sound pink salmon hatchery program has been successful in overcoming limitations in freshwater survival. More recently, Naish et al. (2008) discusses hatchery production in context with the political response to societal demands for salmon and steelhead harvest and conservation. They found that economic analysis rarely plays a role in decision making for that response. They conclude that knowledge gaps may have prevented that information being generated in the past, but suggest that future political responses need not be made in ignorance of economic implications.

G. Measurement Uncertainties and Research Recommendations

The economic measurement estimates presented in this report were systematically derived to provide the best evaluations that were possible. The quality and detail of the data and modeling results gathered has increased the understanding of the magnitude and comparative involvement of the salmon industry in local economies. However, recommendations for further work would be in general to refine data analysis and modeling resolutions. Five particular research recommendations are made.

(1) The economics of hatchery production benefits and costs at a society level were found to have a paucity of investigations. Conclusions by Radtke (2009), Naish et al. (2008), and others have provided information that the business outcomes are a salmon industry subsidy, and at most, could be considered local economic development projects from employment and purchasing at hatcheries. Any linkages of the deleterious effects from hatchery production on wild stocks need to be included on the cost side of the economic value relationships for society level assessments of hatchery production. Radtke (2009) accomplished some pioneering work on production costs in North Pacific countries, but more work is needed at the society cost and benefit level associated with hatcheries.

(2) The conservation of natural production will have a much greater effect on salmon industry profitability for North Pacific countries for several reasons:

- This study has estimated that abundances from natural origin comprise 76 percent by harvest value and 72 percent by harvest weight of the total natural and hatchery fish reaching market. (The proportion of harvests from natural origin is from abundance estimates.)

- There are biological risks (genetic effects, competitive interactions, disease transfer, etc.) associated with salmon hatcheries and economic analysis shows hatcheries to be a subsidy program.
- Hatcheries can interfere with markets (through timing and volume) and cause management issues (exploitation rates of natural origin need to be lower than hatchery origin).

Recommendations for further research should address the effectiveness of natural conservation programs as compared to further proliferation of fishery enhancement hatchery programs.

(3) The prorating of harvests by natural and hatchery origin deserves further study. Ocean survival and escapement were used to estimate abundances for natural and hatchery origin fish. The same proportion was then applied to harvests for the measurement. But management techniques for avoidance (time, area, and gear) and species size as well as select fisheries (retaining marked fish) may invalidate that assumption.

(4) Capture fisheries processing product forms is highly dynamic in response to aquaculture supplies, previous year inventories, and current economic conditions. Market information exists to refine processing product form mix by country. Static averages will degrade accuracy for first wholesale value estimates and economic contribution estimates.

(5) The regional economic contribution model used in this study was developed for the Alaska economy and resulting economic relationships were used as a proxies for the other North Pacific countries. Consistency was cross checked where other investigative results were available. However, a focused and sufficiently scoped/funded study to develop an international econometric model would be a better approach. The modeling would have usefulness beyond just profiling the importance of the salmon fishing industry. It could be applied to policy deliberations among countries on regulations and possible mitigation compensation. Another example use would be its connection to biological models predicting deleterious effects of hatchery programs. The North Pacific supply/demand and open market systems have features and merits that justify such model development.

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End notes

1. *Desk level and first order means existing information from synthesized secondary sources is pulled together and some linear transformations are made that may help characterize subject matter. This is done knowing full-well that fish production, management, and participant behavior may have causal relationships that are non-linear.*

2. *The proxy information was utilized without statistical testing. A more thorough research approach would provide for tests of repeated measures data with missing values. Simulations would be used to compare test results using proxy information instead of just simply utilizing available data.*

3. *Harvest value is the monetary exchange paid by processors to harvesters or when the harvester sells directly to the public. The term is sometimes used interchangeably in this report with ex-vessel value. When the value is expressed as price, the weight used in the denominator is equivalent round pounds of fish. Fish can be landed dressed and partially processed, and there are conversion factors to transform a fish weight as if it was sold as whole. First wholesale value is the sale price of processor products. The term is sometimes used interchangeably in this report with ex-processor value. When expressed as price, the weight used in the denominator is finish pounds. Finish pounds are a measurement after a product form's yield is incorporated. Yields from Crapo et al. (1993) and FAO (2000) were used if data did not use a finish measurement. There is another related cost incurred that must be paid by restaurants and retailers when purchasing seafood products that usually is not reflected in ex-processor value. It is for transportation, cold storage, import/export fees, and other distribution costs.*

4. *The vernacular for study area used in the report will follow the use of the term by Augerot (2005) for "North Pacific."*

5. *The Convention Area is waters of the North Pacific Ocean and its adjacent seas, north of 33 degrees north latitude beyond 200 miles zones of the coastal States. The main objective of the Convention is to promote the conservation of anadromous stocks in the Convention Area. The conservation measures under the Convention are: (1) Prohibition of directed fishing for anadromous fish (chum, coho, pink, sockeye, Chinook, and cherry salmon and steelhead) in the Convention Area; (2) minimization to the maximum extent of the incidental taking of anadromous fish; and, (3) prohibition of the retention on board a fishing vessel of anadromous fish taken as an incidental catch during fishing for non-anadromous fish.*

6. *The NPAFC annual statistical reports include commercial and sport harvests by country and species. Hatchery releases by country are also itemized. Documents from their science program sponsorship and other funded research are conveniently hosted on their website. The documents detail the biology and population trend influences for the North Pacific salmon species.*

7. *The Sumaila et al. (2005) rule-based method is being maintained by the Sea Around Us Project (SAUP). The price database is combined with the catch database developed by Watson et al. (2004). The database is available on the Internet at www.seaaroundus.org. The most recent year in the database is 2004. The outputs for North Pacific countries were incomplete for salmon harvests and data that did exist differed considerably from FAO FishStat and individual country reports. It was decided not to rely on SAUP outputs for estimates.*

8. *Japan has consistently purchased 35 to 45 percent of world salmon production (Johnson and Wiese1995; and Knapp et al. 2007). Japan's salmon market size and integration of capture and aquaculture products has been fodder for a number of studies concerning price relationships. In Japan's salmon market, capture and aquaculture products compete freely. Capture production dominated the Japan salmon market until the late 1980's, but by 2000 salmon aquaculture market share was 69 percent (Asche et al. 2003).*

9. *More recent estimates available through personal communication with the Project authors have extended the period used in this report to 2005.*

10. *The Project limited the modeled species to chum, sockeye, and pink salmon. These species represent 93 percent of all salmon harvests (volume) in 2007 (FAO FishStat, November 2009 extraction).*

11. *There are terminal fisheries with time and area restrictions used to target hatchery origin fish, such as Alaska cost-recovery program fisheries and the Columbia River Select Area Fishery Enhancement Project (SAFE). The SAFE uses a fish mark (clipped adipose fin) to distinguish hatchery origin fish.*

12. *Personal communication, November 2009.*

13. *The job count measure for equivalents may differ from other estimating methods. For example, job counts in Alaska fisheries (Alaska Department of Labor 2009) are a 12 month average of actual employment. Alaska fishing industry employment in 2008 had a July high of 16,308 in the harvesting sector and about an equal number in the processing sector, but the annual average was only 16,297.*

14. *A number of factors will play into negotiated prices including expected supplies, remaining inventories, general economic conditions, other protein prices, and currency conversion rates (Figure 7).*

15. *Asche et al. (2003) talks about the Law of One Price and how it applies, depending on the availability of substitutes. The Japanese salmon price is influenced by aquaculture price because it is a near perfect substitute for capture production.*

16. *Delegates of 91 FAO member countries concluded two years of negotiations on the Agreement. The Agreement was concluded under Article XIV of the FAO Constitution and was formally adopted by the FAO Conference. It is now open for signature and will enter into force 30 days after the 25th ratification is received by the Director-General of the FAO. The Agreement has already been signed by: Angola, Brazil, Chile, the European Community, Japan, Indonesia, Norway, Samoa, the United States, and Uruguay.*

17. *The Act's legislative status as of December 23, 2009 is that it passed the House and was referred by the Senate to the Committee on Commerce, Science, and Transportation.*

18. *Japan EEZ capture fisheries also intercept migration of Russian origin salmon. The Russian EEZ foreign catch is not reported for 2006 and 2007, and is not included in this study. Dronova and Spiridonov (2008) reports this fishery is allowed under agreement between the two countries. This means the Russian government gets agreement funds, but the regional economic impacts from harvesting and processing accrue to Japanese rather than Russia economies.*

19. *In the Pacific Northwest, SAR's are tracked by recovery of coded wire tags (CWT's) inserted in a sample of released smolts. The compilation of the CWT information is expanded to represent the universe sampled. This allows estimates of the origins of fish harvested in the different ocean and river locations by commercial and recreational anglers to be made. For "ocean fish" releases, where marking and tagging become impractical and expensive, a system of temperature marking (otolith growth ring changes according to temperature variations in production facilities) is used. The NPAFC maintains a database of fish country origin based on otolith marking. Genetic stock identification using DNA testing is also being evaluated and applied.*

20. *Freshwater conditions causing smolt mortality would include effects from passage interruptions (such as hydroelectric dams), water quality degradations (such as municipal sewer treatment plant and agriculture non-point discharges), water withdrawals (effects cause elevated water temperatures and salinity intrusions), and predation. Ocean conditions contributing to mortality are less understood, but generally are associated with food availability during migrations (Peterson et al. 2006).*

Table 1
North Pacific Harvests and Economic Value Measurement in 2005 to 2007

2005

Country	Sockeye	Pink	Chum	Coho	Chinook	Total
Harvest						
Total	51,176	343,567	88,481	5,990	1,944	491,158
Canada (BC)	384	7,026	2,157	327	289	10,183
Japan	3	10,588	63,779	26	10	74,406
Republic of Korea	0	0	23	0	0	23
Russia	7,193	164,313	10,004	277	68	181,855
U.S.	43,596	161,640	12,518	5,360	1,577	224,691
Volume						
Total	313,836	1,073,865	691,014	41,034	29,771	2,149,520
Canada (BC)	2,057	27,752	23,201	2,507	4,427	59,943
Japan	15	35,013	490,722	159	198	526,108
Republic of Korea	0	0	121	0	0	121
Russia	43,689	453,308	72,613	1,967	1,261	572,837
U.S.	268,075	557,792	104,357	36,402	23,885	990,511
Ex-vessel value						
Total	229,100	128,864	186,574	31,186	67,580	643,304
Canada (BC)	1,502	3,330	6,264	1,905	10,049	23,050
Japan	11	4,202	132,495	121	450	137,279
Republic of Korea	0	0	33	0	0	33
Russia	31,893	54,397	19,605	1,495	2,863	110,252
U.S.	195,695	66,935	28,176	27,666	54,218	372,690
Finish pounds						
Total	247,109	797,689	594,559	31,945	21,200	1,692,501
Canada (BC)	1,620	20,614	19,963	1,951	3,152	47,300
Japan	12	26,009	422,225	124	141	448,510
Republic of Korea	0	0	104	0	0	104
Russia	34,400	336,726	62,477	1,531	898	436,032
U.S.	211,077	414,340	89,790	28,339	17,008	760,555
Labor cost						
Total	68,854	339,930	90,081	4,761	3,394	507,020
Canada (BC)	451	8,785	3,025	291	505	13,056
Japan	3	11,083	63,971	18	23	75,098
Republic of Korea	0	0	16	0	0	16
Russia	9,585	143,494	9,466	228	144	162,917
U.S.	58,814	176,568	13,604	4,224	2,723	255,933
Ex-processor value						
Total	240,820	777,389	579,429	31,132	20,660	1,649,431
Canada (BC)	1,578	20,090	19,455	1,902	3,072	46,097
Japan	12	25,347	411,480	120	138	437,097
Republic of Korea	0	0	102	0	0	102
Russia	33,524	328,157	60,887	1,492	875	424,936
U.S.	205,706	403,795	87,505	27,618	16,575	741,200
Regional economic contribution						
Total	455,597	787,501	789,351	58,474	112,633	2,203,556
Canada (BC)	2,986	20,351	26,503	3,572	16,748	70,160
Japan	22	25,677	560,555	226	751	587,231
Republic of Korea	0	0	139	0	0	139
Russia	63,423	332,426	82,946	2,802	4,771	486,368
U.S.	389,166	409,048	119,208	51,873	90,364	1,059,658
Direct jobs						
Total						30,574
Canada (BC)						891
Japan						5,200
Republic of Korea						1
Russia						8,281
U.S.						16,200

Table 1 (cont.)

2006

Country	Sockeye	Pink	Chum	Coho	Chinook	Total
Harvest						
Total	55,056	225,689	101,444	5,424	1,394	389,007
Canada (BC)	4,198	755	2,041	145	264	7,403
Japan	28	7,146	61,441	29	8	68,652
Republic of Korea	0	0	45	0	0	45
Russia	8,414	144,950	14,715	430	109	168,618
U.S.	42,417	72,838	23,202	4,820	1,013	144,290
Volume						
Total	319,098	736,559	792,706	40,159	22,284	1,910,806
Canada (BC)	22,280	3,155	21,803	1,228	4,198	52,663
Japan	132	23,790	463,248	214	126	487,510
Republic of Korea	0	0	271	0	0	271
Russia	54,339	439,994	107,957	2,866	1,649	606,805
U.S.	242,349	269,620	199,426	35,851	16,314	763,561
Ex-vessel value						
Total	242,516	117,849	253,666	41,765	67,527	723,324
Canada (BC)	16,933	505	6,977	1,277	12,719	38,410
Japan	101	3,806	148,239	222	381	152,749
Republic of Korea	0	0	87	0	0	87
Russia	41,298	70,399	34,546	2,981	4,997	154,220
U.S.	184,186	43,139	63,816	37,285	49,432	377,858
Finish pounds						
Total	242,595	553,310	673,874	30,264	17,560	1,517,604
Canada (BC)	16,938	2,370	18,535	925	3,307	42,076
Japan	101	17,871	393,804	161	99	412,036
Republic of Korea	0	0	231	0	0	231
Russia	41,311	330,528	91,774	2,160	1,299	467,072
U.S.	184,246	202,541	169,531	27,018	12,854	596,190
Labor cost						
Total	71,440	225,904	111,569	5,463	2,198	416,574
Canada (BC)	4,988	968	3,069	167	414	9,605
Japan	30	7,296	65,199	29	12	72,567
Republic of Korea	0	0	38	0	0	38
Russia	12,165	134,947	15,194	390	163	162,859
U.S.	54,257	82,693	28,068	4,877	1,609	171,504
Ex-processor value						
Total	348,844	795,641	969,008	43,519	25,250	2,182,262
Canada (BC)	24,356	3,408	26,653	1,331	4,756	60,503
Japan	145	25,698	566,277	232	142	592,494
Republic of Korea	0	0	331	0	0	331
Russia	59,404	475,287	131,967	3,106	1,868	671,633
U.S.	264,939	291,248	243,779	38,851	18,484	857,300
Regional economic contribution						
Total	482,277	720,191	1,073,202	78,310	112,546	2,466,525
Canada (BC)	33,673	3,085	29,519	2,395	21,198	89,868
Japan	200	23,261	627,167	417	635	651,679
Republic of Korea	0	0	367	0	0	367
Russia	82,126	430,216	146,157	5,589	8,328	672,416
U.S.	366,278	263,629	269,992	69,910	82,386	1,052,195
Direct jobs						
Total						28,236
Canada (BC)						999
Japan						5,347
Republic of Korea						3
Russia						8,982
U.S.						12,906

2007

Country	Sockeye	Pink	Chum	Coho	Chinook	Total
Harvest						
Total	58,966	349,615	96,316	5,177	1,086	511,160
Canada (BC)	646	6,207	1,010	276	182	8,321
Japan	1	15,557	60,727	6	9	76,300
Republic of Korea	0	0	56	0	0	56
Russia	10,852	183,763	17,280	1,191	137	213,223
U.S.	47,468	144,088	17,243	3,705	758	213,262
Volume						
Total	349,742	1,149,476	698,285	34,897	15,805	2,248,205
Canada (BC)	3,880	24,685	10,717	1,790	2,919	43,991
Japan	2	47,134	437,084	35	99	484,355
Republic of Korea	0	0	322	0	0	322
Russia	66,319	572,819	119,648	8,181	1,766	768,733
U.S.	279,543	504,838	130,515	24,890	11,023	950,809
Ex-vessel value						
Total	279,795	218,400	237,417	33,501	48,527	817,641
Canada (BC)	3,104	4,690	3,644	1,719	8,961	22,117
Japan	2	8,956	148,609	34	305	157,904
Republic of Korea	0	0	109	0	0	109
Russia	53,055	108,836	40,680	7,854	5,421	215,846
U.S.	223,635	95,919	44,375	23,894	33,841	421,664
Finish pounds						
Total	265,892	863,498	593,608	26,298	12,455	1,761,751
Canada (BC)	2,950	18,544	9,110	1,349	2,300	34,252
Japan	2	35,408	371,562	27	78	407,077
Republic of Korea	0	0	274	0	0	274
Russia	50,419	430,307	101,712	6,165	1,391	589,995
U.S.	212,522	379,239	110,950	18,757	8,685	730,153
Labor cost						
Total	78,301	352,547	98,279	4,747	1,559	535,433
Canada (BC)	869	7,571	1,508	244	288	10,479
Japan	0	14,456	61,517	5	10	75,988
Republic of Korea	0	0	45	0	0	45
Russia	14,847	175,685	16,840	1,113	174	208,659
U.S.	62,584	154,835	18,369	3,386	1,087	240,261
Ex-processor value						
Total	329,783	1,070,985	736,244	32,618	15,447	2,185,077
Canada (BC)	3,659	22,999	11,299	1,673	2,852	42,483
Japan	2	43,916	460,844	33	97	504,892
Republic of Korea	0	0	339	0	0	339
Russia	62,534	533,705	126,152	7,647	1,726	731,763
U.S.	263,589	470,366	137,609	23,264	10,772	905,600
Regional economic contribution						
Total	556,411	1,334,670	1,004,456	62,814	80,879	3,039,230
Canada (BC)	6,173	28,662	15,415	3,222	14,935	68,407
Japan	4	54,728	628,729	63	508	684,031
Republic of Korea	0	0	463	0	0	463
Russia	105,507	665,107	172,109	14,726	9,035	966,485
U.S.	444,728	586,173	187,740	44,802	56,401	1,319,844
Direct jobs						
Total						34,500
Canada (BC)						773
Japan						5,566
Republic of Korea						4
Russia						11,800
U.S.						16,357

Table 1 (cont.)

Notes:
1. Harvests are thousands of fish. Volume is in thousands of round pounds.
2. All values are in thousands of $USD (nominal).
3. Steelhead, cherry, and other salmon species are not included in the estimates.
4. Regional economic contribution is household personal income and includes the "multiplier" effect.
5. Ex-processor value (first wholesale value) is based on a ratio of selected products: fresh and frozen whole and H&G, fresh and frozen fillet, salmon roe, canned salmon, and other.
6. Direct jobs are harvesting and processing industry full time equivalent assuming 40 percent labor burdens for the harvest sector and various labor requirements for different salmon product forms for the processing sector.
7. U.S. is Alaska and West Coast salmon fisheries.
8. Russia excludes foreign fleets in Russian EEZ, which were 14 million pounds in 2005, and not available for 2006 and 2007.

Sources: NPAFC Statistical Yearbooks (2005 and 2006); State of Alaska; regional economic contribution ratio is from Dr. Hans Radtke (personal communication), who based his estimates on the Alaska FEAM relationships; Seafood Market Information Service, Seafood Market Bulletins (1997); Institute of Social and Economic Research (2008); Crapo et al. (1993).

Table 2
Economic Modeling Assumptions and Derived Results in 2005 to 2007

2005

Country	Sockeye	Pink	Chum	Coho	Chinook	Total
Fish weight						
Total	6.1	3.1	7.8	6.9	15.3	4.4
Canada (BC)	5.4	3.9	10.8	7.7	15.3	5.9
Japan	5.1	3.3	7.7	6.1	19.8	7.1
Republic of Korea			5.3			5.3
Russia	6.1	2.8	7.3	7.1	18.5	3.1
U.S.	6.1	3.5	8.3	6.8	15.1	4.4
Product mix share of harvest pounds						
Fresh/frozen whole/H&G	55%	29%	82%	71%	58%	45%
Fresh and frozen fillet	6%	5%	8%	21%	37%	7%
Salmon roe	65%	69%	68%	22%	15%	65%
Canned salmon	34%	62%	5%	3%	0%	44%
Other	5%	5%	5%	5%	5%	5%
Ex-vessel price	0.73	0.12	0.27	0.76	2.27	0.30
Ratio of first wholesale value to ex-vessel value						2.219
Ex-processor value per finished pound						0.97

2006

Country	Sockeye	Pink	Chum	Coho	Chinook	Total
Fish weight						
Total	5.8	3.3	7.8	7.4	16.0	4.9
Canada (BC)	5.3	4.2	10.7	8.5	15.9	7.1
Japan	4.7	3.3	7.5	7.4	15.7	7.1
Republic of Korea			6.0			6.0
Russia	6.5	3.0	7.3	6.7	15.1	3.6
U.S.	5.7	3.7	8.6	7.4	16.1	5.3
Product mix share of harvest pounds						
Fresh and frozen H&G	49%	33%	78%	60%	78%	51%
Fresh and frozen fillet	12%	2%	10%	29%	17%	9%
Salmon roe	51%	62%	67%	32%	22%	57%
Canned salmon	35%	60%	7%	6%	0%	36%
Other	5%	5%	5%	5%	5%	5%
Ex-vessel price	0.76	0.16	0.32	1.04	3.03	0.38
Ratio of first wholesale value to ex-vessel value						2.475
Ex-processor value per finished pound						1.44

2007

Country	Sockeye	Pink	Chum	Coho	Chinook	Total
Fish weight						
Total	5.9	3.3	7.2	6.7	14.6	4.4
Canada (BC)	6.0	4.0	10.6	6.5	16.0	5.3
Japan	2.2	3.0	7.2	5.9	11.0	6.3
Republic of Korea			5.7			5.7
Russia	6.1	3.1	6.9	6.9	12.9	3.6
U.S.	5.9	3.5	7.6	6.7	14.5	4.5
Product mix share of harvest pounds						
Fresh and frozen H&G	49%	33%	78%	60%	78%	51%
Fresh and frozen fillet	12%	2%	10%	29%	17%	9%
Salmon roe	51%	62%	67%	32%	22%	57%
Canned salmon	35%	60%	7%	6%	0%	36%
Other	5%	5%	5%	5%	5%	5%
Ex-vessel price	0.80	0.19	0.34	0.96	3.07	0.36
Ratio of first wholesale value to ex-vessel value						2.173
Ex-processor value per finished pound						1.24

2005 to 2007

Country	Sockeye	Pink	Chum	Coho	Chinook	Total
Yield						
Fresh/frozen whole/H&G	85%	85%	85%	85%	85%	
Fresh and frozen fillet	50%	50%	50%	50%	50%	
Salmon roe	4%	6%	8%	7%	6%	
Canned salmon	67%	65%	67%	67%	50%	
Other	67%	65%	67%	67%	50%	
Labor cost per finished pound						
Fresh/frozen whole/H&G						0.09
Fresh and frozen fillet						0.33
Salmon roe						0.50
Canned salmon						0.65
Other						0.18
Ratio of personal income to ex-vessel value	1.989	6.111	4.231	1.875	1.667	

Notes:
1. Price is $USD (nominal).divided by round pounds.
2. The shares of product forms will not equal 100 percent because roe yield is in addition to other product form yield. Roe yield is for female fish.
3. "Other" product form includes all other product forms including smoked products.
4. Some analog products manufactured from whole and H&G are not included in ex-processor valuations.

Sources: NPAFC Statistical Yearbooks (2005 and 2006); State of Alaska; regional economic contribution ratio is from Dr. Hans Radtke (personal communication), who based his estimates on the Alaska FEAM relationships; Seafood Market Information Service, Seafood Market Bulletins (1997); Institute of Social and Economic Research (2008); Crapo et al. (1993).

Table 3
Hatchery Releases of Salmon Fry and Smolts by Species and Country in 2006

Country	Sockeye	Pink	Chum	Coho	Chinook	Total
Total	311.2	1,300.7	2,894.3	74.9	223.1	4,838.2
Canada	230.2	20.3	121.1	11.8	41.1	425.1
Japan	0.3	147.2	1,858.3	0.0	0.0	2,017.2
Republic of Korea	0.0	0.0	7.4	0.0	0.0	7.4
Russia (Far East)	5.4	323.7	336.1	1.9	0.8	670.3
U.S.	75.3	809.5	578.8	61.1	181.3	1,725.6
Alaska	53.5	808.6	541.2	22.7	10.2	1,436.2
West Coast	21.9	0.9	37.6	38.4	171.1	289.4

Notes: 1. Table numbers are millions of fish.
Sources: NPAFC Statistical Yearbook 2006.

Figure 1
North Pacific Salmon Abundance Estimates by Natural and Hatchery Origin for 1990 through 2007

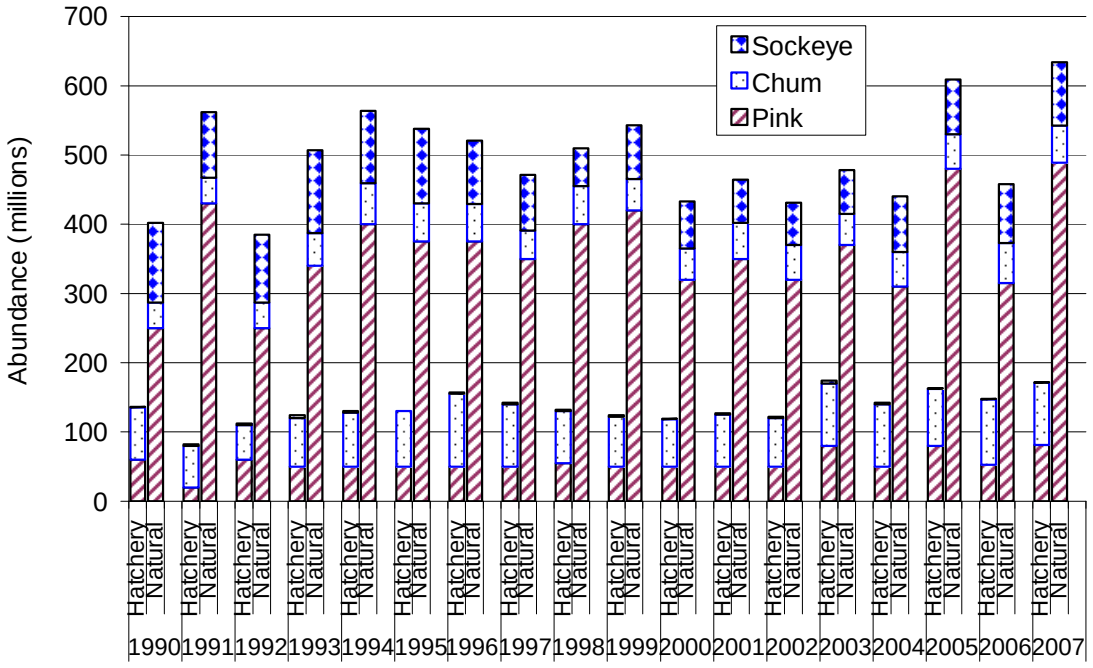
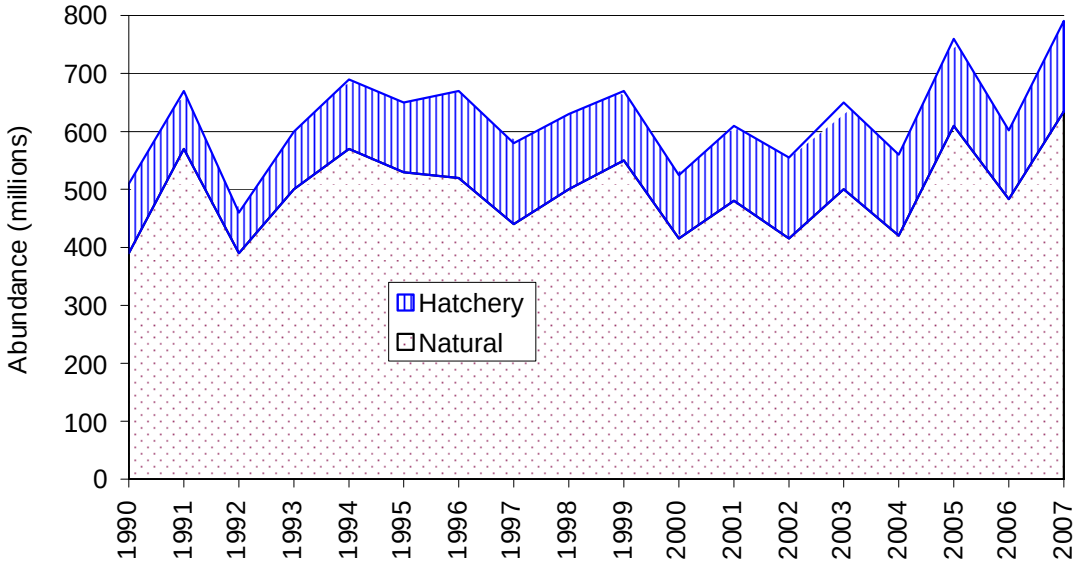


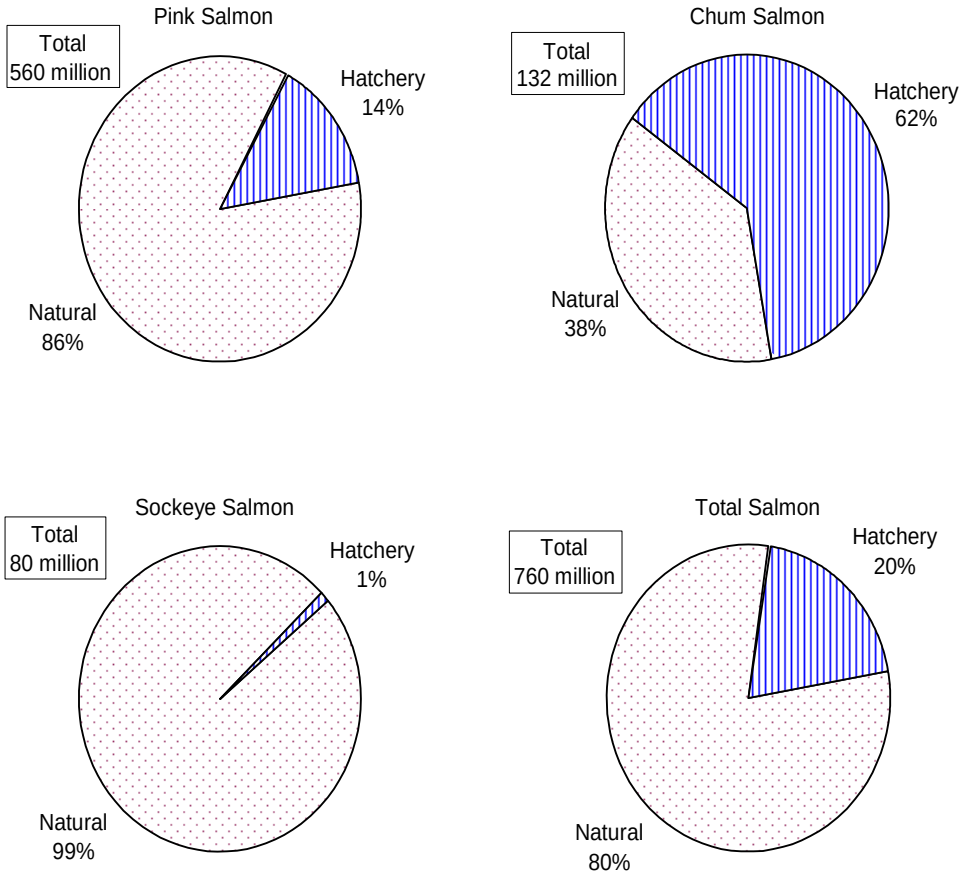
Figure 2
Salmon Natural and Hatchery Abundance Trends in 1990 to 2005



Notes: 1. Abundance is expressed in adult fish counts for harvest plus freshwater escapement.
2. Years 2006 and 2007 are scaled using harvests and 2005 relationships between origin abundance and harvests.

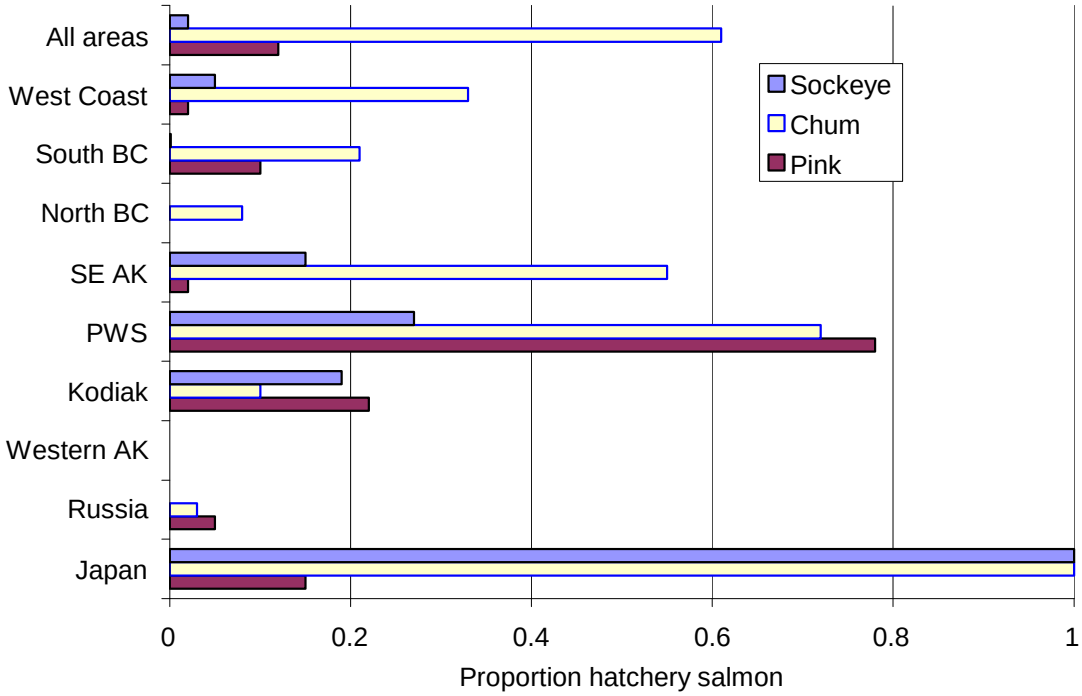
Source: Mantua et al. (2007).

Figure 3
North Pacific Salmon Abundance Natural and Hatchery Origin Share by Species in 2005



Note: Abundance is expressed in adult fish counts for harvest plus freshwater escapement.

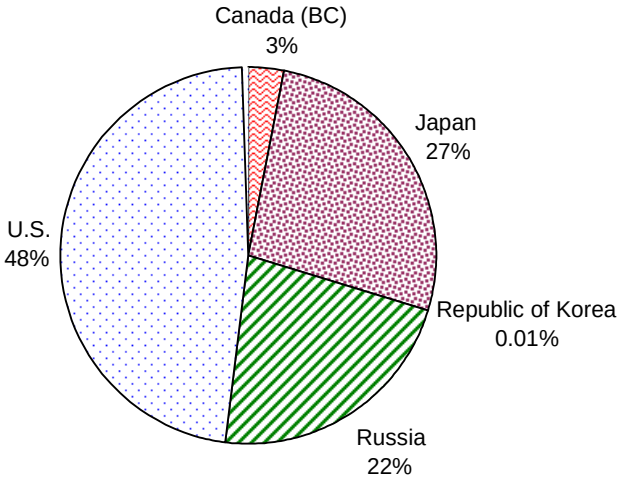
Figure 4
North Pacific Salmon Abundance Hatchery Origin Proportion by Rearing Region for 1990 to 2005



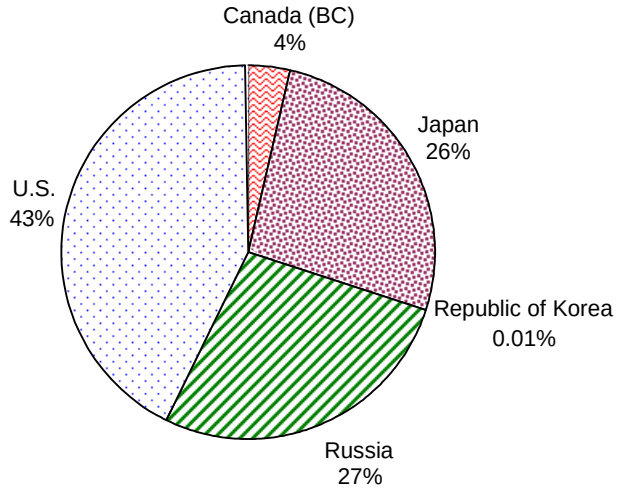
Notes: PWS = Prince William Sound; BC = British Columbia; AK = Alaska.
Source: Mantua et al. (2007).

Figure 5
North Pacific Salmon Regional Economic Contributions in 2005 to 2007

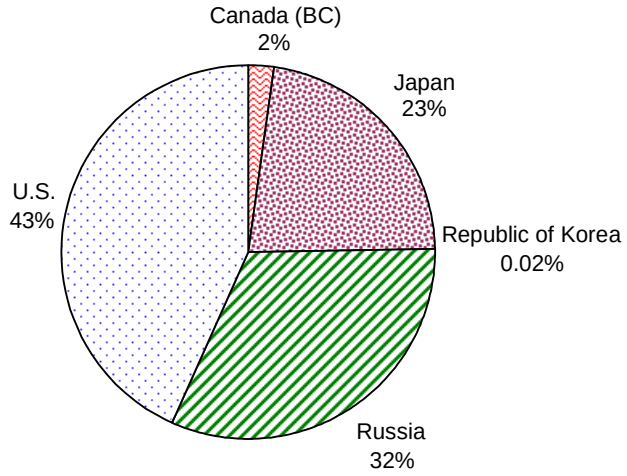
2005



2006

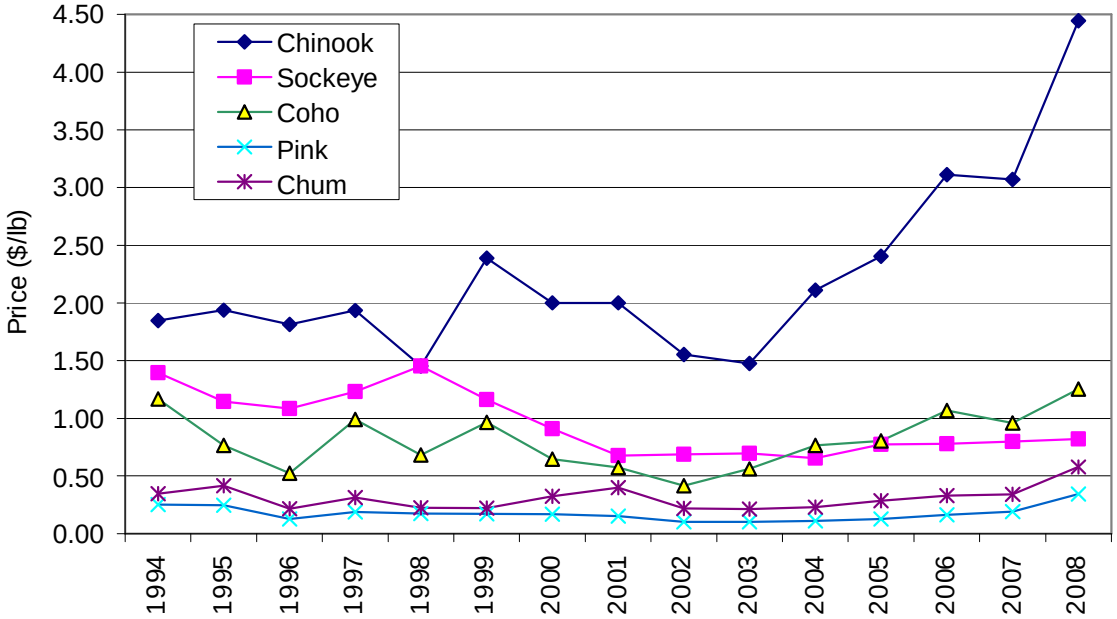


2007



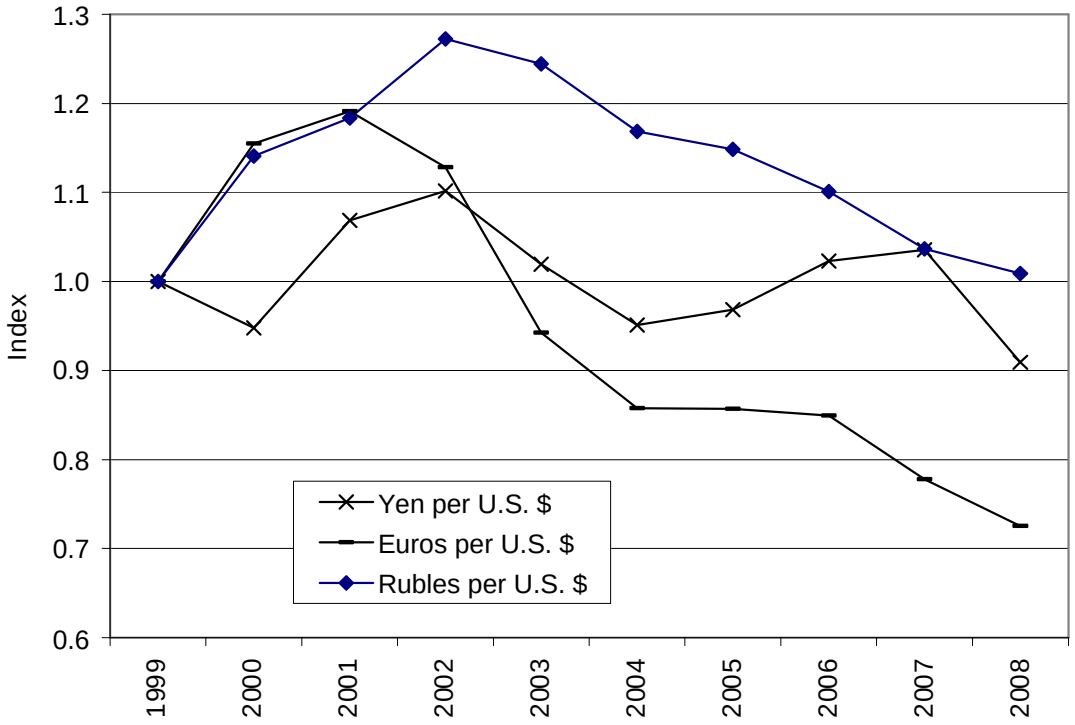
Notes: 1. Regional economic contribution is household personal income and includes the "multiplier" effect.
2. U.S. is the regional economic contribution from Alaska and West Coast salmon fisheries.
Sources: The Research Group.

Figure 6
Alaska Commercial Salmon Price Trends in 1994 to 2008



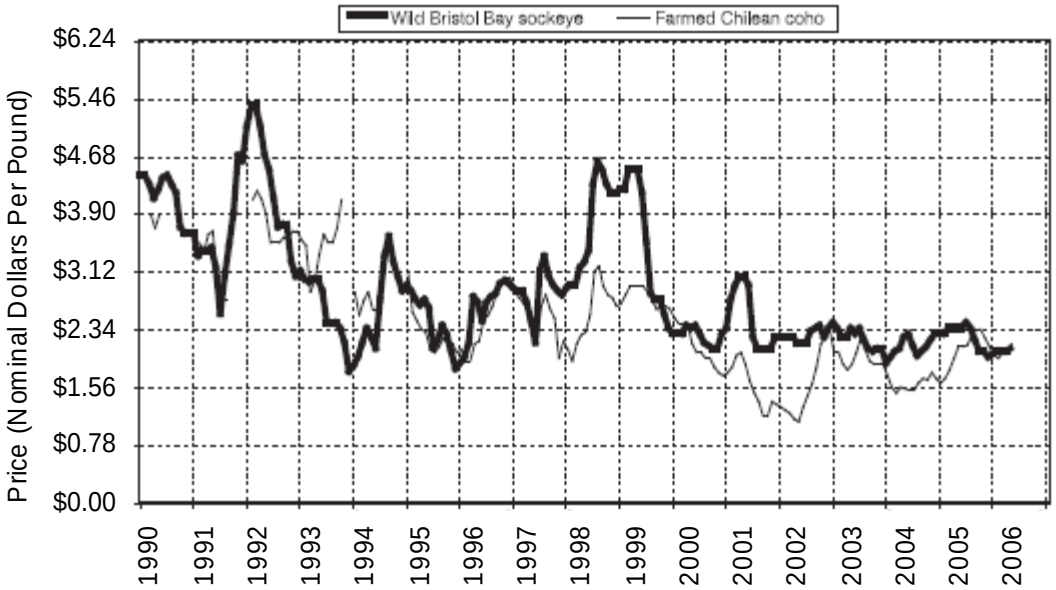
Notes: 1. Prices adjusted to 2007 dollars using the GDP implicit price deflator developed by the U.S. Bureau of Economic Analysis.
Source: Alaska Dept. of Fish and Game, Division of Commercial Fisheries, Alaska Commercial Salmon Harvests and Ex-vessel Values tables.

Figure 7
Currency Trends in 1999 to 2008



Notes: 1. Currencies are indexed to Year 1999=1.
Source: Exchange rates from Board of Governors of the Federal Reserve System for Yen and Euros. Rubles from Wikipedia.

Figure 8
Japanese Wholesale Prices of Alaska Wild and Chilean
Aquaculture Frozen Salmon Products in 1990 to 2006



Notes: 1. Prices are nominal low list prices for four to six pound No. 1 grade fish.
2. Yen to dollar conversion from Board of Governors of the Federal Reserve System for Year 2006.

Source: Knapp et al. (2007).

APPENDIX

Table A-1
Global Aquaculture and Capture Production by Salmon Species in 2003 to 2007

Species		2003	2004	2005	2006	2007
			Aquaculture			
Atlantic salmon	Quantity	1,147,862	1,267,447	1,255,905	1,328,556	1,433,708
Chinook(=Spring=King)salmon	Quantity	22,030	8,146	10,191	9,832	11,542
Chum(=Keta=Dog)salmon	Quantity	2	1			
Coho(=Silver)salmon	Quantity	105,869	98,192	115,623	130,959	115,376
Masu(=Cherry) salmon	Quantity					
Pacific salmons nei	Quantity					
Salmonoids nei	Quantity	2,689	2,479	1,650	1,532	3,249
Sockeye(=Red)salmon	Quantity					
Total	Quantity	1,278,452	1,376,265	1,383,369	1,470,879	1,563,875
Share		59%	63%	59%	63%	61%
Atlantic salmon	Value	3,439,930	4,175,932	4,910,917	6,695,519	7,578,273
Chinook(=Spring=King)salmon	Value	55,727	48,912	61,127	72,321	83,272
Chum(=Keta=Dog)salmon	Value	14	7			
Coho(=Silver)salmon	Value	341,114	335,562	525,448	523,913	456,091
Masu(=Cherry) salmon	Value					
Pacific salmons nei	Value					
Salmonoids nei	Value	4,658	4,487	3,739	2,780	6,054
Sockeye(=Red)salmon	Value					
Total	Value	3,841,444	4,564,900	5,501,231	7,294,534	8,123,690
			Capture Production			
Atlantic salmon	Quantity	3,648	4,081	3,727	3,084	2,989
Chinook(=Spring=King)salmon	Quantity	15,046	15,899	13,571	10,482	8,906
Chum(=Keta=Dog)salmon	Quantity	360,429	351,188	318,389	331,900	303,205
Coho(=Silver)salmon	Quantity	16,995	24,546	18,791	18,226	17,200
Masu(=Cherry) salmon	Quantity	1,944	1,608	1,563	834	810
Pacific salmons nei	Quantity	-	<0.5	<0.5	-	<0.5
Pink(=Humpback)salmon	Quantity	377,749	266,554	456,350	319,005	495,986
Salmonoids nei	Quantity	3,140	2,746	1,984	23,006	19,944
Sockeye(=Red)salmon	Quantity	109,822	142,385	147,151	151,123	164,222
Total	Quantity	888,773	809,007	961,526	857,660	1,013,262
Share		41%	37%	41%	37%	39%
			Total Aquaculture Plus Capture Production			
Atlantic salmon	Quantity	1,151,510	1,271,528	1,259,632	1,331,640	1,436,697
Chinook(=Spring=King)salmon	Quantity	37,076	24,045	23,762	20,314	20,448
Chum(=Keta=Dog)salmon	Quantity	360,431	351,189	318,389	331,900	303,205
Coho(=Silver)salmon	Quantity	122,864	122,738	134,414	149,185	132,576
Masu(=Cherry) salmon	Quantity	1,944	1,608	1,563	834	810
Pacific salmons nei	Quantity	-	<0.5	<0.5	-	<0.5
Pink(=Humpback)salmon	Quantity	377,749	266,554	456,350	319,005	495,986
Salmonoids nei	Quantity	5,829	5,225	3,634	24,538	23,193
Sockeye(=Red)salmon	Quantity	109,822	142,385	147,151	151,123	164,222
Total	Quantity	2,167,225	2,185,272	2,344,895	2,328,539	2,577,137
Share		100%	100%	100%	100%	100%

Notes: 1. Aquaculture value is first wholesale value in nominal U.S. dollars.
2. Quantity is tonnes (1,000 kg). Tonnes (metric tons) are equal to 2,204.62 pounds.
Source: FAO FishStat database, November 2009 extraction.

Table A-2
Capture for North Pacific Countries by Salmon Species and Fishing Areas in 2004 to 2007

Country	Species	Fishing area	2004	2005	2006	2007
Canada	Atlantic salmon	Atlantic, Northwest	-	-	-	-
Canada	Chinook(=Spring=King)salmon	Pacific, Northeast	2,460	2,008	1,831	1,323
Canada	Chum(=Keta=Dog)salmon	Pacific, Northeast	14,112	10,523	9,889	4,861
Canada	Coho(=Silver)salmon	Pacific, Northeast	1,143	1,137	510	811
Canada	Pink(=Humpback)salmon	Pacific, Northeast	3,575	12,588	1,430	11,196
Canada	Salmonoids nei	America, North - Inland waters	-	-	-	-
Canada	Sockeye(=Red)salmon	Pacific, Northeast	4,323	933	10,048	1,758
Japan	Chinook(=Spring=King)salmon	Pacific, Northwest	109	156	140	130
Japan	Chum(=Keta=Dog)salmon	Asia - Inland waters	19,103	16,269	.	.
Japan	Chum(=Keta=Dog)salmon	Pacific, Northwest	242,476	226,249	201,000	192,900
Japan	Coho(=Silver)salmon	Pacific, Northwest	89	129	100	100
Japan	Masu(=Cherry) salmon	Asia - Inland waters	667	629	.	.
Japan	Masu(=Cherry) salmon	Pacific, Northwest	932	922	820	800
Japan	Pink(=Humpback)salmon	Asia - Inland waters	628	852	.	.
Japan	Pink(=Humpback)salmon	Pacific, Northwest	12,360	16,220	14,400	13,830
Japan	Salmonoids nei	Asia - Inland waters	-	-	17,477	16,465
Japan	Sockeye(=Red)salmon	Asia - Inland waters	39	33	.	.
Japan	Sockeye(=Red)salmon	Pacific, Northwest	2,587	2,744	2,440	2,340
Korea, Republic of	Salmonoids nei	Asia - Inland waters	.	.	1,878	20
Korea, Republic of	Salmonoids nei	Pacific, Northwest	16	15	37	102
Russian Federation	Atlantic salmon	Atlantic, Northeast	75	85	72	55
Russian Federation	Atlantic salmon	Europe - Inland waters	31	13	15	25
Russian Federation	Chinook(=Spring=King)salmon	Europe - Inland waters	105	205	264	254
Russian Federation	Chinook(=Spring=King)salmon	Pacific, Northwest	263	395	578	575
Russian Federation	Chum(=Keta=Dog)salmon	Europe - Inland waters	11,019	20,250	27,834	28,561
Russian Federation	Chum(=Keta=Dog)salmon	Pacific, Northeast	-	409	546	909
Russian Federation	Chum(=Keta=Dog)salmon	Pacific, Northwest	13,816	8,117	23,997	26,469
Russian Federation	Coho(=Silver)salmon	Europe - Inland waters	797	442	671	2,303
Russian Federation	Coho(=Silver)salmon	Pacific, Northwest	1,510	679	1,052	1,650
Russian Federation	Masu(=Cherry) salmon	Europe - Inland waters	7	9	6	9
Russian Federation	Masu(=Cherry) salmon	Pacific, Northwest	2	3	8	1
Russian Federation	Pink(=Humpback)salmon	Atlantic, Northeast	-	136	3	171
Russian Federation	Pink(=Humpback)salmon	Europe - Inland waters	23,576	42,680	29,161	43,593
Russian Federation	Pink(=Humpback)salmon	Pacific, Northeast	-	64	1	120
Russian Federation	Pink(=Humpback)salmon	Pacific, Northwest	91,261	159,454	173,420	219,572
Russian Federation	Salmonoids nei	Europe - Inland waters	873	772	1,282	1,203
Russian Federation	Salmonoids nei	Pacific, Northeast	-	2	-	-
Russian Federation	Salmonoids nei	Pacific, Northwest	703	247	1,344	1,227
Russian Federation	Sockeye(=Red)salmon	Europe - Inland waters	11,263	15,742	16,338	21,370
Russian Federation	Sockeye(=Red)salmon	Pacific, Northeast	-	-	-	337
Russian Federation	Sockeye(=Red)salmon	Pacific, Northwest	9,231	7,845	14,052	12,959
United States of America	Atlantic salmon	Atlantic, Northwest	.	.	.	.
United States of America	Chinook(=Spring=King)salmon	America, North - Inland waters	531	298	403	271
United States of America	Chinook(=Spring=King)salmon	Pacific, Eastern Central	2,992	2,205	538	724
United States of America	Chinook(=Spring=King)salmon	Pacific, Northeast	9,438	8,302	6,727	5,628
United States of America	Chum(=Keta=Dog)salmon	America, North - Inland waters	136	951	971	867
United States of America	Chum(=Keta=Dog)salmon	Pacific, Northeast	50,526	35,621	67,663	48,638
United States of America	Coho(=Silver)salmon	America, North - Inland waters	1,478	735	769	690
United States of America	Coho(=Silver)salmon	Pacific, Eastern Central	-	-	-	-
United States of America	Coho(=Silver)salmon	Pacific, Northeast	19,529	15,669	15,124	11,646
United States of America	Pacific salmons nei	Pacific, Northeast	<0.5	<0.5	-	<0.5
United States of America	Pink(=Humpback)salmon	America, North - Inland waters	-	-	-	-
United States of America	Pink(=Humpback)salmon	Pacific, Eastern Central	-	-	-	-
United States of America	Pink(=Humpback)salmon	Pacific, Northeast	135,154	224,356	100,590	207,504
United States of America	Sockeye(=Red)salmon	America, North - Inland waters	29	-	-	-
United States of America	Sockeye(=Red)salmon	Pacific, Northeast	114,913	119,854	108,245	125,458

Country	2004	2005	2006	2007
Canada	25,613	27,189	23,708	19,949
Japan	278,990	264,203	236,377	226,565
Korea, Republic of	16	15	1,915	122
Russian Federation	164,532	257,549	290,644	361,363
United States of America	334,726	407,991	301,030	401,426

Species	2004	2005	2006	2007
Atlantic salmon	106	98	87	80
Chinook(=Spring=King)salmon	15,898	13,569	10,481	8,905
Chum(=Keta=Dog)salmon	351,188	318,389	331,900	303,205
Coho(=Silver)salmon	24,546	18,791	18,226	17,200
Masu(=Cherry) salmon	1,608	1,563	834	810
Pacific salmons nei	<0.5	<0.5	-	<0.5
Pink(=Humpback)salmon	266,554	456,350	319,005	495,986
Salmonoids nei	1,592	1,036	22,018	19,017
Sockeye(=Red)salmon	142,385	147,151	151,123	164,222

Fishing area	2004	2005	2006	2007
America, North - Inland waters	2,174	1,984	2,143	1,828
Asia - Inland waters	20,437	17,783	19,355	16,485
Atlantic, Northeast	75	221	75	226
Atlantic, Northwest	-	-	-	-
Europe - Inland waters	47,671	80,113	75,571	97,318
Pacific, Eastern Central	2,992	2,205	538	724
Pacific, Northeast	355,173	431,466	322,604	420,189
Pacific, Northwest	375,355	423,175	433,388	472,655

Notes: 1. Quantity is tonnes (1,000 kg). Tonnes (metric tons) are equal to 2,204.62 pounds.
Source: FAO FishStat database, November 2009 extraction.

Table A-3

Export, Import, and Production Quantity and Value by North Pacific Country and Product Forms in 2007

Export Quantity

	Canada	Japan	Korea, Den	Korea, Rep	Russian Fe	U.S.
Atlantic and Danube salmons, fresh or chilled	69,657					3,513
Salmon steaks, frozen						-
Sockeye salmon (red salmon)(Oncorhynchus nerka), frozen	466	224		3		31,974
Salmon steaks, fresh or chilled						-
Salmon nei, not minced, prepared or preserved		62	-	131	503	2,706
Coho salmon, not minced, prepared or preserved	23					
Salmonoids fillets, frozen	1,323				345	
Pacific salmon, fresh or chilled	5,742	1				6,918
Salmon fillets, fresh or chilled	5,079					
Salmon minced, preparations	305	-				1,017
Pacific salmon, frozen, nei	7,577	57,050	-	954	55,804	90,142
Salmonoids, salted or in brine				-		
Atlantic salmon and Danube salmon, frozen	90	1		4	123	926
Salmons, fresh or chilled, nei	50		-		40	356
Salmon nei, not minced, prep.or pres, in airtight containers		-		-		
Salmonoids, fresh or chilled, nei	2	-	-	-	2	372
Salmon fillets, frozen						-
Chum salmon, not minced, prepared or preserved	35					594
Sockeye salmon, not minced, prepared or preserved, nei	3,214					27,341
Salmons, salted or in brine	43	-	-	-		-
Pacific salmons nei, not minced, prepared or preserved	114					
Salmonoids, frozen	51	2	-	38	971	14,290
Salmon roes, cured	91		-			779
Salmon nei, not minced, in oil, prepared or preserved						516
Salmon roes, frozen	363					11,010
Salmonoids fillets, fresh or chilled					3	
Salmons, smoked	245	1		1	45	281
Pink salmon, not minced, prepared or preserved, nei	3,094					19,628

Export Value

	Canada	Japan	Korea, Den	Korea, Rep	Russian Fe	U.S.
Atlantic and Danube salmons, fresh or chilled	394,825					16,279
Salmon steaks, frozen						-
Sockeye salmon (red salmon)(Oncorhynchus nerka), frozen	3,742	1,204		18		129,457
Salmon steaks, fresh or chilled						-
Salmon nei, not minced, prepared or preserved		890	-	833	576	9,640
Coho salmon, not minced, prepared or preserved	139					
Salmonoids fillets, frozen	11,934				1,736	
Pacific salmon, fresh or chilled	42,149	8				26,010
Salmon fillets, fresh or chilled	50,869					
Salmon minced, preparations	2,909	-				4,626
Pacific salmon, frozen, nei	25,615	110,320	-	5,641	133,619	247,469
Salmonoids, salted or in brine				-		
Atlantic salmon and Danube salmon, frozen	428	6		24	347	4,365
Salmons, fresh or chilled, nei	281		-		46	2,685
Salmon nei, not minced, prep.or pres, in airtight containers		-		-		
Salmonoids, fresh or chilled, nei	8	-	-	-	17	2,261
Salmon fillets, frozen						-
Chum salmon, not minced, prepared or preserved	157					1,597
Sockeye salmon, not minced, prepared or preserved, nei	29,792					128,671
Salmons, salted or in brine	410	-	-	-		-
Pacific salmons nei, not minced, prepared or preserved	902					
Salmonoids, frozen	190	36	-	89	2,219	38,553
Salmon roes, cured	1,564		-			12,392
Salmon nei, not minced, in oil, prepared or preserved						2,064
Salmon roes, frozen	4,443					110,396
Salmonoids fillets, fresh or chilled					35	
Salmons, smoked	4,015	25		6	353	5,127
Pink salmon, not minced, prepared or preserved, nei	13,936					56,994

Table A-3 (cont.)

Import Quantity

	Canada	Japan	Korea, Den	Korea, Rep	Russian Fe	U.S.
Atlantic and Danube salmons, fresh or chilled	3,940	21,577				81,162
Salmonoids, fresh or chilled, nei	269	-	-	-	-	46
Sockeye salmon (red salmon)(Oncorhynchus nerka), frozen	3,864	45,731	-	4	45	77
Salmonoids, not minced, prepared or preserved					1	
Pacific salmons nei, not minced, prepared or preserved	18,587					
Chum salmon, not minced, prepared or preserved						-
Salmons nei, frozen		-			25,103	
Pacific salmon, fresh or chilled	3,453	930				4,903
Salmonoids, dried, salted or in brine		-				
Salmon steaks, fresh or chilled						-
Salmon roes, cured						40
Pacific salmon, frozen, nei	5,295	77,892	176	1,317	5,172	2,085
Salmonoids, salted or in brine				-		
Salmon fillets, frozen	7,014		-		482	31,737
Salmons, fresh or chilled, nei	386	-	-	3,379	40,692	703
Salmon nei, not minced, prep.or pres, in airtight containers	334	1,270		12		-
Salmon roes, frozen						27
Salmons, smoked	199	482	-	56	61	3,561
Pink salmon, not minced, prepared or preserved, nei						3,872
Salmonoids, frozen	182	178	-	100	966	348
Salmon fillets, fresh or chilled			-		71	90,971
Sockeye salmon, not minced, prepared or preserved, nei						100
Atlantic salmon and Danube salmon, frozen	79	2,394	22	7,573		2,992
Salmon nei, not minced, prepared or preserved	1,020	9,565	-	53	134	2,142
Salmon minced, preparations					62	3,841
Salmon nei, not minced, in oil, prepared or preserved	39					172
Salmon steaks, frozen						-
Salmonoids fillets, fresh or chilled	7,634					
Salmonoids fillets, frozen	181				-	21,390
Salmons, salted or in brine				-	-	92

Import Value

	Canada	Japan	Korea, Den	Korea, Rep	Russian Fe	U.S.
Atlantic and Danube salmons, fresh or chilled	18,730	147,414				457,209
Salmonoids, fresh or chilled, nei	1,650	2	-	-	3	312
Sockeye salmon (red salmon)(Oncorhynchus nerka), frozen	19,399	209,393	-	19	93	505
Salmonoids, not minced, prepared or preserved					8	
Pacific salmons nei, not minced, prepared or preserved	70,106					
Chum salmon, not minced, prepared or preserved						-
Salmons nei, frozen		-			93,164	
Pacific salmon, fresh or chilled	16,985	7,628				32,190
Salmonoids, dried, salted or in brine		4				
Salmon steaks, fresh or chilled						-
Salmon roes, cured						963
Pacific salmon, frozen, nei	14,817	303,251	248	5,214	8,648	10,551
Salmonoids, salted or in brine				-		
Salmon fillets, frozen	41,938		-		2,301	241,495
Salmons, fresh or chilled, nei	2,878	-	-	21,261	185,746	4,603
Salmon nei, not minced, prep.or pres, in airtight containers	1,613	6,721		137		-
Salmon roes, frozen						347
Salmons, smoked	2,375	7,400	-	1,075	731	44,846
Pink salmon, not minced, prepared or preserved, nei						16,798
Salmonoids, frozen	642	977	-	288	1,499	1,745
Salmon fillets, fresh or chilled			-		353	705,506
Sockeye salmon, not minced, prepared or preserved, nei						764
Atlantic salmon and Danube salmon, frozen	538	12,149	111	42,636		16,053
Salmon nei, not minced, prepared or preserved	6,126	61,487	-	879	861	15,281
Salmon minced, preparations					244	25,112
Salmon nei, not minced, in oil, prepared or preserved	127					876
Salmon steaks, frozen						-
Salmonoids fillets, fresh or chilled	67,528					
Salmonoids fillets, frozen	715				-	98,065
Salmons, salted or in brine				-	-	182

Production Quantity

	Canada	Japan	Korea, Rep	Russian Fe	U.S.
Chinook salmon, not minced, prepared or preserved	-				-
Chum salmon, not minced, prepared or preserved	35				2,437
Salmons, salted or in brine	43	109,044		.	46
Salmon fillets, fresh or chilled					11,822
Salmon roes, cured	91	8,200			612
Salmon steaks, fresh or chilled					.
Pacific salmons nei, not minced, prepared or preserved		3,787			
Salmonoids fillets, fresh or chilled					16
Salmonoids, dried, salted or in brine					-
Salmonoids, smoked					-
Salmon roes, frozen	363				11,010
Pacific salmon, frozen, nei	7,577	172,310		149,362	78,360
Salmon steaks, frozen					-
Salmon fillets, frozen					22,475
Salmonoids, frozen			38		
Salmons, smoked	245	.		.	6,946
Pink salmon, not minced, prepared or preserved, nei	3,094				38,367
Sockeye salmon, not minced, prepared or preserved, nei	3,214				23,803
Salmonoids fillets, frozen					-
Coho salmon, not minced, prepared or preserved	23				-
Salmon nei, not minced, prepared or preserved			131	10,607	-
Sockeye salmon (red salmon)(Oncorhynchus nerka), frozen					35,830
Salmons nei, frozen	90				

Source: FAO FishStat database, November 2009 extraction.