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THE HONORABLE MICHAEL H. SIMON

IN THE UNITED STATES DISTRICT COURT

FOR THE DISTRICT OF OREGON

PORTLAND DIVISION

NATIONAL WILDLIFE FEDERATION, *et al.*,

Plaintiffs,

and

STATE OF OREGON,

Intervenor-Plaintiff,

v.

NATIONAL MARINE FISHERIES SERVICE, *et al.*,

Defendants,

and

PUBLIC POWER COUNCIL, *et al.*,

Intervenor-Defendants.

Case No. 3:01-CV-00640-SI

DECLARATION OF DR. DARRYLL OLSEN IN SUPPORT OF INTERVENOR-DEFENDANT COLUMBIA-SNAKE RIVER IRRIGATORS ASSOCIATION RESPONSE TO PLAINTIFFS' MOTIONS FOR PRELIMINARY INJUNCTION

Darryll Olsen, Ph.D. declares:

1. I am the Board Representative/Principal Consultant for Intervenor-Defendant Columbia-Snake River Irrigators Association ("CSRIA"). My qualifications to make this Declaration are summarized in Exhibit 1 attached hereto. My work experience includes direct review and preparation of several technical reports/publications on Columbia-Snake River system operations and fish studies related to potential impacts to system changes. This work has covered the mid-1990s to the present. I have previously provided Declarations to the Court within the context of the current litigation.

2. CSRIA fully supported the litigation stay that was rejected by the Federal Administration in July 2025 (per Presidential Memorandum, June 2025), and appears in response to the Plaintiffs' Motion for Preliminary Injunction solely to address the remedy sought by Plaintiffs relating to operating levels for John Day and McNary Pools upon which its members depend to grow irrigated crops in Oregon and Washington.

CSRIA's Role in the BiOp Litigation MOU-Settlement Commitments.

3. CSRIA fully participated in the federal mediation process that led to the signed MOU (and Commitments/Settlement) allowing for continued review and study of Lower Snake River ("LSR") and Columbia River hydro project operations. This review period existed within a litigation stay approved by the Court. CSRIA was the *sole industry group* to support the December 14, 2023 Memorandum of Understanding ("MOU") under the stay, and to publicly voice our cooperation with the Plaintiffs' and Defendants' decision.

4. CSRIA did not support the Presidential Memorandum withdrawing from the MOU and Commitments. CSRIA leadership views the Administration's withdrawal as a terrible mistake in judgement, effectively compelling the Plaintiffs to reengage litigation that had been displayed and forthcoming prior to the litigation stay approved by the Court. The stay review period, five-to-ten years, has been abandoned via Executive directive.

5. Sponsored by the Washington State Legislature and the Office of Columbia River, Ecology, CSRIA prepared a technical report assessing the impacts to irrigated agriculture from dam breaching in the LSR. This report is the *only state-federal examination* that deals with irrigation impacts. CSRIA believes that this report would have been part of the review materials considered in the process under the litigation stay. A true copy of this report is attached hereto as Exhibit 2.

CSRIA Perceives the Renewed Litigation as Undirected.

6. CSRIA understands the Plaintiffs' frustration with the Administration's *de facto* rescinding of the litigation stay and terminating further review of the LSR hydro system changes. But the renewed litigation simply "punishes" all parties, including a key stakeholder who supported the litigation stay. Although an Intervenor-Defendant, CSRIA sought to work with the Plaintiffs during the mediation and early stages of the stay period to consider multiple alternatives to LSR hydro operations. We acted in good faith with the Plaintiffs, and recognized further analysis of the dam breaching issue was appropriate under the National Environmental Policy Act, though this Court held we did not have standing to pursue the argument (Order, Aug. 12, 2021 [Doc. No. 2394]).

7. The broad scope of measures demanded by the Plaintiffs' injunctive relief motions is designed to be punitive, attempting to force the Defendants to change course and bring back a full-scale review of LSR hydro operations, including dam breaching. But that approach also harms an Intervenor-Defendant like CSRIA, who supported the litigation stay and demonstrated a clear willingness to support the litigation review in a collaborative manner with the Plaintiffs. The minimum operating pool ("MOP") remedy sought in Plaintiffs' injunctive relief motions unjustly injures CSRIA members and irrigators. The proposed reservoir pools drawdowns to MOP levels will substantially disrupt irrigation pumping for about forty independent pumping stations located along McNary and John Day Pools threatening roughly 400,000 acres of irrigated agricultural production.

Uncertain Fish Benefits, Certain Costs from MOP Operations.

8. In contrast to the harm from MOP operations, actual juvenile (or adult) fish survival benefits gained from MOP operations in McNary and John Day Pools have never been empirically measured or demonstrated. No such system operations have occurred where fish survival benefits have been measured in the pools—none. Suggestions of incremental benefits moving from normal or irrigation pool levels to MOP are based on assumptions regarding water particle travel time changes associated with some degree of unknown correlation assigned to survival within pools. There have never been empirical observations to validate the "correct" correlations or survival improvements—none.

9. Most of the estimates of incremental MOP-related improvements to juvenile fish survival were developed in the 1990-2000 period, for various agency fish and wildlife programs and modeling sensitivity analyses, summarized in Exhibit 3 attached hereto. Using non-empirically based modeling assumptions, the range of MOP survival improvements generally are/were between 0-2%, a figure that refers only to survival improvements in the John Day Pool reach, not for total system survival (all Columbia River and ocean systems). There appear to be no recent individual in-pool estimates for the McNary and John Day Pools MOP operations (CRSO, 2020 EIS). The in-river survival estimates reflect multiple reach survival data (NOAA Fisheries), with no estimates for incremental MOP operations per pool. Reduced smolt residence/travel time in particular pools are believed to be associated with less mortality *in such pools*, but the overall system and life cycle survival changes are not really known.

10. In-pool fish survival gains also are fully overshadowed by other factors within the migration system, for both in the river and ocean environments. For example, the magnitude of fish survival impacts dominated by ocean conditions can obliterate any incremental MOP river system passage survival estimates. The ocean-conditions factor has been well known, and measured, since the mid-1990s. Among other technical analyses, the USACE Inter-Basin comparison study, 1994, empirically demonstrated the massive influence of ocean conditions on Columbia-Snake River fish stocks. A true copy of this study is attached hereto as Exhibit 4.

11. MOP operations in McNary and John Day Pools will have observable, empirical irrigation impacts, as water elevations would drop by six feet or more at all

pump stations. John Day Pool generally operates at about an elevation of 262.5 to 264 ft., and MOP would make the elevation about 257 ft. At that level, water access can change (such as at the Mercer Ranches, Columbia Water and Power, and Simplot sites), and stressed pumping levels will occur causing cavitation (such as at the Sandpiper Farm, other sites). Protective fish screens require constant cleaning at all sites, and pumping power costs would increase for all pump stations. On McNary Pool, MOP operations would have severe impacts to some stations ability to have access and pumping capability (at a site like the Simplot pump station).

12. Given the operational variation among all pump station sites in McNary and John Day Pools (WA and OR), it is premature to state fully reliable station cost estimates, but initial, real world, on the ground experience, would put capital costs for retrofit in the $100-200 million range. In addition, increased annual pumping, maintenance and replacement (OM&R) costs could be in the $10-20 million range. Only more elaborate engineering and economic analyses can provide better cost estimates. Hence the need for a more realistic timetable for any MOP operations.

MOP Drawdown Actions—Time and Other Considerations.

13. It is impossible to avoid harm to the irrigators without providing adequate time to assess MOP pump station impacts and mitigation strategies. No such MOP action on McNary and John Day Pools should be considered until 2029 at the earliest. Needless harm should be avoided, not part of an objective.

14. The Court can and should consider, as an alternative to the relief sought by Plaintiffs, pool drawdowns with far less impacts, perhaps establishing new pool

operations at elevations 2-3 ft. below current Minimum Irrigation Pool levels. At John Day Pool, this would set the range at about 260-261 ft. Even this type of change would dramatically modify impact levels not just for irrigators, but also for power and navigation operations and for several other commercial and non-commercial (environmental) activities along the pools. Planning and engineering to provide these smaller changes could provide more expedited implementation than a full MOP drawdown.

15. Any judicial relief relating to changes in pool operating levels, whatever the planning horizon, should provide more specific planning requirements for the Federal Defendants, including that they recognize any future mitigation costs

I certify under penalty of perjury that the foregoing is true and correct to the best of my knowledge.

Dated: December 11, 2025.

Darryll Olsen, Ph.D., Board Representative
Columbia-Snake River Irrigators Association

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Affiliation/Experience/Education:

Dr. Olsen serves as Board Representative for the Columbia-Snake River Irrigators Association, a technical/policy/legal srevices irrigation group; he has worked with CSRIA since 1992. He also has worked directly or consulted with Argonne National Laboratory (hydro power review), Pacific NW Utilities Conference Committee (power resources planner), Northwest Irrigation Utilities (power rate allocations and ESA-EIS issues), the U.S. Army Corps of Engineers (Columbia River fish survival reports and economic values), and several other state/local agencies and private firms.

He has extensive experience in water resources management including decades of work on Columbia-Snake River ESA-NEPA litigation, and water right review for Water Conservancy Boards (changes/transfers). He has prepared detailed economic impact studies for the Odessa Subarea irrigation development (state sponsored review); the Southeast Idaho groundwater irrigation impacts; and the Lake Power Pipeline (UT) water supply study (Colorado River).

He is principal investigator for the WA State sponsored irrigation economics impact report for potential Lower Snake River dam breaching actions (2024); and he drafted the intial legislative bills for the Columbia Basin Water Supply Act and WA State Water Conservancy Boards.

He holds the degree of Ph.D. from Washington State University (1983), conveyed by the Office of Applied Energy Studies, the Program in Environmental Science and Regional Planning, and The Departments of Agricultural Economics-Rural Sociology at WSU, with a focus in resource economics and regional planning (economic impacts). He has published several key studies in resourecs economics (fish and power), and served as principal investigator for multiple studies dealing with Columbia-Snake River operations (Salmon Decision Analysis, Economic Value of Columbia River Salmon and Steelhead, Inter-Basin Comparison Study, others).

He has previously served as an Adjunct Graduate Faculty member with WSU Tri-Cities, for teaching Environmental Science/Regional Planning-490/590, water resources econonmics and mangement; and offering special topics lectures in resource management and water resources economics.

Irrigation Sector Economic Impacts on the Lower Snake River
Benchmark Review for Dam Breaching and Mitigation Costs

Ice Harbor Dam Tailrace, Lower Snake River (2023)

Prepared For:

Office of Columbia River
WA State Department of Ecology
And the Washington State Legislature

Prepared By:

Franklin Conservation District
Pasco, WA

Columbia-Snake River Irrigators Association
Kennewick, WA

January 2024

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This benchmark review is already dated as it is being written, as it reaches into an unknown future, where decisions affecting dam breaching on the Lower Snake River (LSR) are far from being certain--particularly as they impact mainstem irrigation projects along Ice Harbor and Upper McNary pools.

The LSR EIS litigation settlement agreement, approved by the Plaintiffs and Defendants, defers significant physical changes to the LSR hydro projects by at least five to ten years. In real-world terms, decisions would have to be determined and reconstruction measures executed today, for irrigation systems to be operational by 2030.

Nevertheless, the economic impacts can be placed in today's context for executive and legislative considerations.

Irrigation Impact Area:

- This review designates a well-specified impact area, taking into account the full effect of dam breaching and pool drawdowns on the LSR and Columbia River system. The primary impact area covers about 92,500 acres served by the Ice Harbor and Upper McNary Pools.

Irrigation Pump Station Modifications:

- The breaching of Ice Harbor Dam would lower the water surface elevations making all of the existing irrigation pump stations located in the pool inoperable; and changes to river topography and huge volumes of siltation would affect pumping stations below the existing Ice Harbor Dam tailrace to the confluence of the Walla Walla River and McNary Pool.
- Direct reconstruction costs are considered to be water pumping infrastructure costs associated with significant modifications or replacement of irrigation pump platforms and/or pumps, intakes and screens entering the river, manifolds from the pumps to the mainline piping systems, associated electrical connections, all excavation works, and drilling replacement wells.
  - The direct station-by-station reconstruction costs are estimated to be between $92-184 million (2021$). Future costs are expected to escalate significantly.
  - A main pipeline configuration is estimated to cost at least $500 million to $1 billion.
  - Reconstruction timelines from design to operations are estimated to be about 2-5 years.
  - Minimal disruption to irrigation water service is estimated to be about 1-2 years (unavoidable).

Risk Mitigation Cost Estimates:

- The risk mitigation assessment methodology accepts that national economic development (NED) impacts would manifest as "distressed" land values under dam breaching conditions. This value impact would be about $578 to 759 million.
  - $578 to 759 million required mitigation payments to land-irrigation project owners.
  - Estimated shared debt (financing) obligations by Bonneville Power Administration and Washington State would be about $35 to $47 million, annually.

Regional Household Income Impact Estimates:

- The potential regional economic development (RED) impacts are estimated as annual value of household income tied to the affected irrigation area, defined as the Irrigated Agriculture Industry, with direct, indirect, and induced impacts to regional income.
  - Total regional income values (impacts) are estimated to range between $450 to $464 million.
  - It would be impossible to mitigate fully regional income impacts, if LSR dam breaching occurred.

Irrigation Sector Economic Impacts on the Lower Snake River
Benchmark Review for Dam Breaching and Mitigation Costs

Figure 1. Ice Harbor Pool Irrigation Pump Station, South Shoreline Location (2023)

This review is already dated as it is being written, as it reaches into an unknown future, where decisions affecting dam breaching on the Lower Snake River (LSR) are far from being certain--particularly as they impact mainstem irrigation projects along Ice Harbor and Upper McNary pools, the two lower system hydro projects. The review is a glimpse-in-time today, that dimly illuminates tomorrow's decisions.

The LSR litigation settlement agreement approved by the Plaintiffs and Defendants defers significant physical changes to the LSR hydro projects by at least ten years.[1] There would have to be renewed litigation actions to bring breaching or deep pool drawdowns forward between 2025-2030. That only could happen if the key Plaintiffs—the Nez Perce Tribe or EarthJustice—perceive little gain in the current Federal Hydro Agencies' commitments to change LSR hydro project operations. The commitments may prove to be unsatisfactory to achieving the Plaintiffs' long-stated objective to bring change to the LSR hydro system. Even so, the decision timeframe would likely extend more than a decade for actual irrigation project reconstruction work to commence. Revised irrigation development plans and economic impact and mitigation assessments would be revised, once more. In real-world terms, decisions would have to be determined and reconstruction measures executed today, for irrigation systems to be operational by 2030.

So being, the review conveys a "benchmark" perspective to understand and quantify irrigation sector impacts. It forms a picture from which to visualize potential impact mitigation measures and to provide insight into the "opportunity costs" associated with LSR dam breaching.

[1] U.S. Federal Administration Agencies Commitments and Agreements, Federal Mediation and Consiliation Service (FMCS) Process, December 15, 2023, as transferred to the U.S. Federal District (OR) Court, Portland, Oregon.

1. Legislative and Executive Direction.

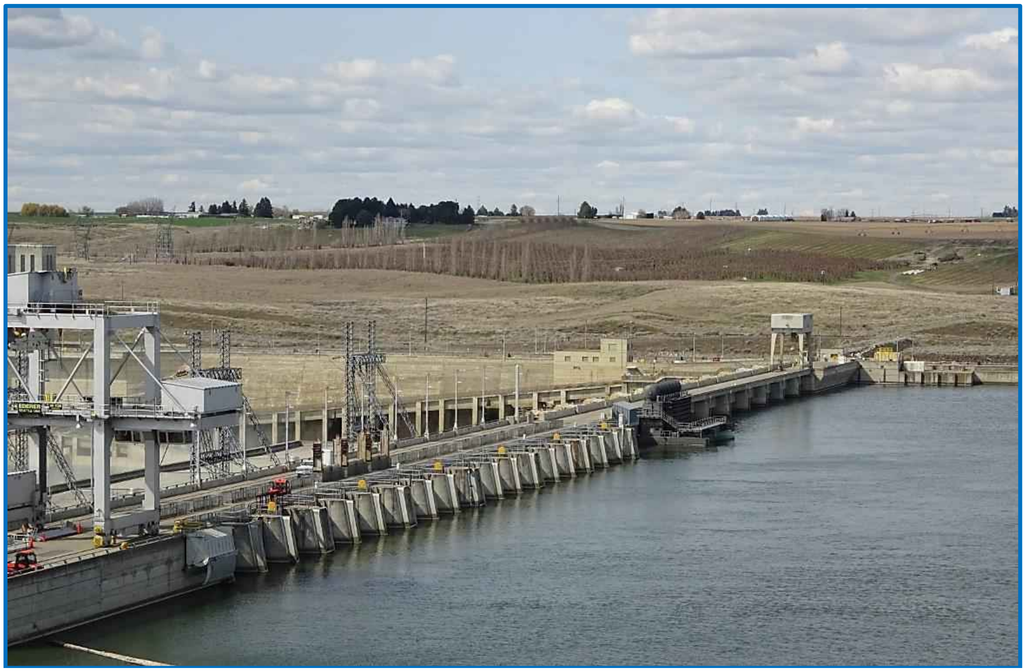

Figure 2. Ice Harbor Dam Forebay with Irrigation Fields in Background (2023)

Responding to the study recommendations made earlier in 2022 by Washington Governor Jay Inslee and U.S. Senator Patty Murray,[2] the Washington State legislature reauthorized funding for a more complete review of impacts to the irrigation sector stemming from LSR dam breaching during the 2023 legislative session.

This directive to the Office of Columbia River (OCR), Ecology, specifically asked OCR to address:

1) Existing information and studies dealing with irrigation sector (infrastructure) impacts.
2) Potential mitigation needs to irrigators to off-set breaching impacts.
3) Impacts to water rights.
4) Cost estimates for direct irrigation system impacts and modifications/upgrades.
5) Interim approaches to supplying irrigation water during the actual pool(s) drawdown phase.

In this review, some additional irrigation impacts and issues are considered, including:

6) Irrigation sector impacts below the Ice Harbor tailrace caused by four-dam breaching; flow elevation and siltation-debris impacts.

[2] "Lower Snake River Dams Replacement Services Report," Prepared for WA Gov. Jay Inslee, Sen. Patty Murray, Olympia, WA, October 2022.

7) Whether realistic timelines for preconstruction engineering and infrastructure modifications can be/should be pursued? Can irrigation water pumping operations precede stable and suitable water quality conditions?

8) Are there some impact areas, like regional household secondary income impacts, that cannot be realistically mitigated, where seasonal production disruption occurs?

2. State/Federal Litigation-Policy History and Direction.

The LSR projects--Lower Granite, Little Goose, Lower Monumental, and Ice Harbor—were constructed during the 1962-1975 period. Since construction, about half of the projects' operating life has been subjected to Endangered Species Act (ESA) litigation, with an initial ESA violation filing made by EarthJustice in 1992. The Federal Courts have upheld several operating challenges levied by EarthJustice, representing about ten regional environmental and sport fishing groups, with support from others. Over the course of thirty years, project operations have been significantly altered to obtain survival improvements to migrating juvenile salmon and steelhead, and returning adult fish. These changes have principally affected hydro power production, to increase flows over the spillways, as opposed to power production, as well as other operational and system changes.

The project operations to date have not directly affected irrigation operations along the river. The irrigation pumping systems rely on stable reservoir levels created by the LSR dams, and portions of the Upper McNary Pool reaching into the tailrace of the Ice Harbor Dam. But things could change.

In 2016, U.S. Federal District (OR) Judge Michael Simon vacated the 2014 Biological Opinion for Columbia-Snake River hydro project operations, a centerpiece for fish protection under the Endangered Species Act (ESA). He accepted the argument by the state of Oregon, EarthJustice, and other plaintiffs that the Columbia River System Operation (CRSO) agencies had failed to include adequate operation measures to protect thirteen "listed" salmon and steelhead species from "risk of extinction." In doing so, Judge Simon further ordered the CRSO agencies to prepare a new Environmental Impact Statement (EIS), that would become the technical foundation for a new Biological Opinion, changing hydro project operations. His order was very specific, in that he told the agencies to review in detail a Lower Snake River dam breaching/drawdown alternative.[3]

The CRSO agencies completed the Final EIS in September 2020.[4] It was immediately challenged by the BiOp litigation plainfiffs, EarthJustice, et al., the state of Oregon, and with Tribal support. Rather than file immediately in 2021 for injunctive relief, the plaintiffs agreed to pursue a litigation "stay" with the federal agencies (U.S. Army Corps of Engineers, Bonneville Power Administration, U.S. Bureau of Reclamation-Interior, and NOAA Fisheries). The stay period was to determine if a settlement agreement could be fashioned that would meet the plaintiffs' dam breaching objective and still mitigate for major river system

[3] Order by U.S. Federal District (OR) Judge Michael Simon, Case 3:01-cv-00640-SI Document 2065 Filed May 4, 2016, Pages 1-149

[4] USACE, BPA, USBR, NOAA Fisheries, "Final Columbia River System Operations EIS," Portland, OR (Washington DC), September 2022.

economic industries, the electric power production, Lower Snake River (LSR) barge navigation, and irrigation projects along the Ice Harbor-Upper McNary pools.[5]

Proceeding concurrently with the Federal EIS Process, the Washington State legislature approved funding for a stakeholder study to address issues associated with the possible removal of the four LSR dams. This study was supported by Gov. Inslee and Sen. Murray. Its two conclusions were: 1) the LSR dams should be breached to protect/restore salmon and steelhead recovery; and 2) dam breaching should be conditional on providing "replacement services" to the major industries being affected. Recognizing the technical deficiencies associated with the first study, the legislature authorized a second study to deal more thoroughly with the dam breaching proposition; during the 2023 legislative session, legislators and Gov. Jay Inslee approved funding for further state review of LSR dam breaching impacts to the irrigation sector.

This benchmark review responds to the 2023 legislative-Administrative directive, taking into account "on-the ground" knowledge of the irrigation projects and decades of experience in adhering to resource economics standards that require federal and state principles and regulations.

3. Water Right Impacts.

The primary review area along Ice Harbor and McNary pools affects about 92,500 acres, served by multiple surface and groundwater water rights (see Tables 6-9 and Figures 5-8). These rights consist of permits, certificates, and claims. The rights are in good standing as documented within the Washington State Dept. of Ecology database (water right mapping data, October 2023). These rights' irrigated acres estimates have been calibrated against the Washington State Department of Agricultural 2022 Crop Mapping data, used here to estimate the total impact area for Ice Harbor and McNary Pools.

During an irrigation pump station modification phase, all of the rights will likely be curtailed by reconstruction activity. Unavoidable cessation of water right use would likely be about 1-2 years, a period of time that would not invoke relinquishment of the rights under state water law (RCW-90.14.140). Further, the rights are protected from legal provisions interfering with their use, and the litigation/Court directives for Lower Snake River dam breaching would apply in this situation. If further protection from relinquishment is deemed necessary, the rights could be placed in the Temporary Trust Instream Program (RCW 90.42) for the period of disruption, and then reactivated thereafter.

It can be concluded with certainty that the water rights are secure from nonuse relinquishment or other regulatory impediments. The water rights would remain unchanged in private sector hands.

4. Impact Measures.

a. Irrigation Station Reconstruction Costs.

The breaching of the LSR dams would have significant adverse direct impacts to the existing irrigation pump stations and irrigation wells serving tens of thousands of acres of high value irrigation lands lying adjacent to

[5] Some relatively small amounts of irrigated acres exist along the Lower Monumental Pool, about 700 acres.

the Snake River above Ice Harbor Dam. Additionally, the irrigation pump stations lying below Ice Harbor Dam, located in the McNary Pool, would experience impacts to their water intakes.

Direct reconstruction costs are considered to be water pumping infrastructure costs associated with significant modifications or replacement of irrigation pump platforms and/or pumps, intakes and screens entering the river, manifolds from the pumps to the mainline piping systems, associated electrical connections, all excavation works, and drilling replacement wells.

Modifying River Pump Stations.

The breaching of Ice Harbor Dam would lower the water surface elevation of the Snake River by about 80 ft. at the dam forebay, changing pool elevations from where the existing irrigation pump stations are located. This would make all of the existing irrigation pump stations located above Ice Harbor Dam inoperable. Each pump station is unique, but each pump station will require at least some significant changes to intake and screen structures, some requiring extensive piping and platform changes.

The river pump stations located below Ice Harbor Dam also would be impacted. The breaching of the Lower Snake River Dams will result in millions of tons of sediment to travel down the Snake River[6] and be deposited in the Columbia River above McNary Dam—primarily below the tailrace area below (the existing) Ice Harbor Dam, and along the north shore between the Snake-Columbia River confluence and the confluence with the Walla Walla River. This sedimentation will have severe impacts on the pump station water intakes making those pump stations inoperable. It also is very unclear how the new river topography would evolve below Ice Harbor Dam affecting variable flow fluctuations/elevations during the irrigation season.

Several of the independently owned intake, pumping units, platforms, and manifolds/mainline systems share platform infrastructure. There are approximately 25 independent surface water pumping units within the Ice Harbor Pool and Upper McNary Pool (north shore) to the Walla Walla River confluence, serving production irrigated agriculture.

Wells.

There are numerous groundwater wells located along the Lower Snake River above Ice Harbor Dam. These wells are in hydraulic continuity with the Lower Snake River and as such their static water levels are directly impacted by the water level in the Snake River. The breaching of Ice Harbor Dam would lower the water surface elevation, where most of these irrigation wells are sited (some in the Upper McNary Pool deemed to be largely unaffected). The associated lowering of static water levels in the wells would effectively make them inoperable and require modifications.

In most places, new wells would need to be constructed. Most of the existing wells penetrate either the alluvial sands and gravels lying adjacent to the river, or the shallow basalt aquifer. In either case lowering the static water levels 30 to 90 feet will make them inoperable. This will require drilling wells further into the basalts. New drilling will likely have mixed results, as this has been previously attempted at locations along the river, with some wells being productive and others not. If adequate groundwater cannot be obtained,

[6] CRSO Agencies, "Columbia River System Operations Environmental Impact Statement," 2020.___

additional river pump stations may be required to obtain the water needed for the project currently being irrigated from well(s).

Like the river pump stations, the wells along the river differ greatly. None are identical, making cost estimates for modification very difficult to estimate.

b. Direct Net Assets and Mitigation—National Economic Development.

The concepts and analyses for irrigation sector direct economic impacts, with inherent mitigation measures, should be modeled on well-established principles for federal water resources management. This standard should incorporate direct net value (NED) changes to water distribution and land assets, predicated on observable, market-based determinations for willingness-to pay.

Resource economics valuation methods for land and water investments have long-embraced fundamental principles for changes to net social welfare (utility) using market-based transactions.[7] This work largely identifies changes to NED values determined through basic measures of willingness-to-pay, opportunity costs, and avoided/replacement costs. These types of marginal value changes can reflect both direct net benefits and costs.

Specific to these economic evaluations: *"Risk and uncertainties should be identified and described in a manner that is clear and understandable to the public and decision makers. This includes describing the nature, likelihood, and magnitude of risks (including quantitatively where feasible)…Mitigation of adverse effects associated with each plan, strategy, or action is to be an integral part of all alternatives."*[8]

The Lower Snake-Columbia River irrigation sector impacts would cover the total asset values of the pump stations and water delivery system modifications, the loss of agricultural production/markets during re-construction, and the costs to on-site product processing facilities. In total, this represents the full asset value being impaired (or potentially lost); it is the direct net impact (value) that should be included under National Economic Develop accounting--that should be used in all CRSO and State impact studies.

This asset value is best measured by the market value of the land that "bundles" all values in a land transaction between buyers and sellers. This is the true expression of willingness-to-pay, and it measures the direct net value baseline for the existing water/land assets, as well as allowing for a determination of the impaired asset value under breaching/drawdown conditions.

The breaching/drawdown action would create "distressed assets," where the assets' value in the market is diminished. The distressed assets are created by the risks associated with the uncertain costs of modifying pump stations, the unknown time frame for loss of operations, how effective the future pumping operations would be, and how the agricultural production markets respond to interruptions to site-specific supply.

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[7] Since the 1950s, federal water resources management agencies have followed methodologies outlined in evolving forms of "Principles and Guidelines" (WA-DC 1982); or "Principles and Requirements for Federal Investments in Water Resources in Water Resources" (CEQ-DOI 2013, CEQ 2014 and 2015); and described historically in Alvin Goodman, "Principles of Water Resources Planning," Prentice Hall, 1984.

[8] "Principles and Requirements," CEQ, March 2013, October 2019.

It is this inherent asset risk that defines the irrigation sector costs and the required mitigation compensation caused by breaching/drawdowns. Like the baseline asset value, the risk mitigation impairment value can be best measured by the market—what is the market's willingness-to-pay for land assets that will be subject to breaching/drawdowns.[9] What does the change to asset market value reveal?

c. Regional Income Impacts—Regional Economic Development (RED).

The RED economic impacts consist of household dollar impacts most often referenced in irrigation project developments—the stream of income obtained from direct agricultural production, agricultural support services, and food processing (nondurable goods manufacturing). These "direct" sectors serve other "indirect" sectors throughout the economy and create "induced" impacts from additional household expenditures. It is the total composition of inter-weaving economic sector purchases and sales that compose Regional Economic Development, described as income value.

d. Focus on Acre-Level Impacts.

The Review economic impact study requires a common denominator to better understand and interpret what is being measured. In this review, the economic impacts are determined, and summarized, at the irrigated acre level. The review impact measures are threefold.

An ability to estimate future reconstruction impacts for diverse pump stations becomes more practical to first assess acre costs for recent reconstruction/develop projects, and then apply this range to the full impact acreages under review (approximately 92,500 acre).

For estimating direct net economic development (NED) impacts, with mitigation, the focus is on establishing a baseline for irrigated acres market value (2021$ estimates). And for regional economic development (RED) impacts, reasonable household income impacts can be assigned to the project acres as an average value per acre.

Bringing these three economic impact areas to an acre-value common denominator also provides decision makers with a more appreciable metric for considering the magnitude of impact levels. For example, reconstruction cost alternatives can vary greatly, and most land owners view project cost impacts across their own farm acreages.

5. The Economic Impact Area.

a. Franklin-Walla Counties.

The review irrigation pump stations are located in Franklin and Walla Walla counties. The affected acreages are displayed in Figures 5 and 6 and Tables 6-8. Both the project reconstruction costs and NED impacts are easily assigned to these acreage locations. This does not hold true for the RED impacts, as some portion of the household income estimates "leak" into Benton County, or the state. The INPLAN model and state-wide Bureau of Economic Analysis (BEA) derived estimates take this into account, unless specified otherwise.

[9] It is unclear to CSRIA if the USBR will accurately measure fully the Irrigation Sector impacts, and how they will account for asset value changes.

b. Ice Harbor Pool and McNary Upper Reach Pool to Walla Walla River Confluence.

The irrigation sector requires a well-specified impact area, taking into account the full effect of dam breaching and pool drawdowns on the Mainstem Snake and Columbia River system. The primary impact area includes the Ice Harbor and Upper McNary Pools displayed in Figures 5 and 6.

In total, approximately 92,500 acres are being irrigated along the pools.[10] About 54,900 acres are served by the Ice Harbor Pool,[11] and about 37,600 are served below Ice Harbor Pool and along the Upper McNary Pool reach.

Under the four Lower Snake River dam breaching alternatives, the Ice Harbor Pool would be lowered by about 80 ft. at the project forebay location (assuming some remaining in-river head elevation). This creates a deep pool drawdown condition for all pumping stations (and wells), eliminating existing water access to the pumping intakes. The topography of the river system is not 90 degrees vertical, but involves various gradients depending on location. Under breaching conditions, the entire pump station intake system would have to be rebuilt and debris/fish screens rebuilt/repositioned. In several cases, pumping plants would need to be reconfigured and repositioned. The overall stability of the existing pool elevations would change, and with a narrowed/reconfigured channel, pumping elevations would fluctuate—the reconstructed pump stations would need to be rebuilt to function under these variable conditions. The existing pool stability would no longer exist, moderating river elevations for river flows varying between 20-120 kcfs during the irrigation season.

The Upper McNary Pool reach would be very problematic under dam breaching conditions, as it is unclear what would happen to reconfigured pool stability between Ice Harbor Dam and the Snake River confluence; and the area below the confluence to the mouth of the Walla Walla River is a shallow backwater area. This entire eastern-side reach area would be severely affected under minimum operating pool (MOP) drawdowns on the McNary Pool, about 2-6 ft., that are included within the EIS alternatives and could be employed in combination with Lower Snake River dam breaching. Even without McNary MOP operations, the Lower Snake River siltation deposits will settle in the McNary Pool backwater area, requiring major dredging and pump station intake reconfiguration measures.

The 4-dam LSR breaching action would likely have some degree of impact on other portions of the McNary Pool not considered in this review. Some siltation impacts should be expected, but the level of pumping impairment is highly speculative, and cannot be quantified until actual river system operations change. Vegetation and river debris problems should be expected leading to more operation and maintenance needs.

[10] Estimates based on irrigated acres/water rights data reviewed from the Washington State Dept. of Agriculture Crop Mapping Project (2018); the Washington State Dept. of Ecology GWIS and WRTS data bases (2019); and data modeling by the Benton-Franklin Conservation District (2019). See Figures 1 and 2.

[11] About 800 acres above Ice Harbor Pool below Lower Monumental.

Figure 3. Irrigation Pump Station on Upper McNary Pool, Backwater Area (2022)

Figure 4. Pump Station Intake-Screen Structure into Pool (2022)

6. Reconstruction Cost Estimates, Potential Pump Station Costs Per Acre.

a. Direct Reconstruction Approach.

The most direct approach to estimating potential impacts, and associated mitigation costs, to pump station infrastructure reconstruction is to assess existing pump station modifications or developing new structures, along the Lower Snake-Columbia River system. There have been several projects that either have been reconstructed or built within the past six years, that offer some insight into a cost range that could apply to the LSR projects.

In Table 1, available cost estimates are displayed for recent project modifications and new development. The projects considered here are large-scale in pumping requirements, all have intake systems that are somewhat similar in design to the affected dam breaching projects, and have similar types of infrastructure configurations. The projects exist on the Mainstem Columbia-Snake River system.

Table 1. Cost Estimates for Existing/New Projects

Pump Station- Project Location	Construction Modification	Estimated 2021$	Estimated Direct Acres Served	Estimated $/Acre
Lower McNary Pool	New Pump Station Infrastructure 50% Intake Structure	$32,500,000 $12,500,000	16,000	$2,030 $780
Upper McNary Pool	Rebuilt Intakes-Pump Station Modification	$16,250,000	15,0000	$1,080
Ice Harbor Pool	Rebuilt Intakes-Pump Station Modifications	$8,750,000	5,200	$1,680
John Day Pool	Rebuilt Intakes- Screens	$5,000,000	16,000	$310
Ice Harbor-McNary* Pools New Structures	Intakes-Pump Station Manifold-Electric	$12,000,000	5,000	$2,500
John Day Pool** 2024 Development	New Well Drilled	$750,000	400	$1,880
Ice Harbor Pool* Existing Project	Redrilled Wells Casing, Pumps	$600,000	205	$2,930
Ice Harbor Pool* Existing Project	Redrilled Wells Casing, Pumps	$3,000,000	3,000	$1,000
Estimated Cost Mid-Range/Acre				$1,000-$2,000
Estimated Cost Range for 92,500 Acres				$92,000,000 To $184,000,000

Sources: Existing and future costs estimates from CSRIA Representatives/Members, IRZ Consulting, Benton-Franklin County Water Conservancy Board cost estimates.
<u>Escalation rates to 2021 costs from:</u>
Mortenson Construction Cost Index for Portland, OR: 2018-2021, 30%.
Federal Reserve Economic Data, Costs Index for Producers-Construction: 2016-2021, 29%.
Energy News Record, Heavy Construction Index: 2016-2021, 21%.
*Future development cost estimate (CSRIA); Since 2021, construction cost estimates have increased by about 14-20%.
** Cost estimate from Benton County Water Conservancy Board, 2021$. Project to be built in 2024.

The estimates provided are based on actual, private sector construction costs during the 2016-2021 period, with estimates updated to reflect 2021 construction dollars.[12] The costs are provided as estimated direct capital costs for specific acreages, with costs allocated on a per acre basis. Taken as a broad range, the costs per acre, per project, span from about $300/acre to about $1,800/acre. A future estimate also is provided for a "generic" pump station modification, visualizing upward costs to about $2,500/acre. CSRIA's consulting engineers indicate that unknown reconstruction factors could readily increase this future cost estimate.

Applying the above costs to reflect reconstruction projects suggest a mid-range of about $1,000 to $2,000/acre. Further applying this cost range to the overall impact area of about 92,000 acres, suggests total reconstruction costs falling in the $92 to $184 million range. The higher estimate of this cost range may capture a large set of unknowns affecting each pumping system and assumes a certain amount of efficiency that would have to be obtained in the reconstruction process.

This reconstruction approach is estimated to take about 1-4 years from design to operations, and it is accepted that at least 1-2 year of irrigation disruption would occur, as some of the reconstruction work would likely take place after a pool drawdown occurs. It also is uncertain whether siltation problems would severely affect new pumping system operations, further delaying irrigation production. The design, construction, and re-started operations would have to be precisely coordinated.

b. River Pump Station Reconstruction with Main Pipeline Design.

Another approach to pump station reconstruction would be to forego direct project-by-project redevelopment and instead rely on a main pipeline configuration, where either existing pump stations tie-in to the new main pipeline; or the pipeline is routed to an upriver field elevation (with reregulation reservoir). New pumping units would then be connected to the system.

It is most likely that two new intake-screen systems would be sited upriver from the existing irrigation projects, feeding new lift stations on both sides of the river. From the lift stations, large pipelines would require road-causeway construction for supporting the new pipelines. This could be designed along the existing railroad-bed on the north bank or along the "new" riverbank along the south side—two new pipeline corridors. Under this configuration, existing river pump stations could be used with tie-ins to the main pipelines, with water then using existing distribution lines to the fields.

The above pipeline approach also could be modified to pump from the new riverbed intake site, to reregulation reservoirs on both sides of the river. From the reregulation reservoirs, main pipelines would then distribute water to specific field areas downriver. New boosting pump units would be built at the field locations.

The above is a very, very brief conceptual sketch of shifting to a large-scale pumping-piping system that would require significant design work and coordinated construction with river dam breaching activity. Like the project-by-project approach, it would require at least 1-4 years from design to operations, or likely a longer period. It is uncertain whether it could be developed without some delays in irrigation production, perhaps for 1-2 years.

[12] The cost estimates do not include net power costs (net present value over time).

In this review, no attempt is made to design such a system or make formal cost estimates. But given previous work in building several pipelines and pump stations along the Columbia-Snake River system, this type of project could easily be in the $500 million to $1 billion cost[13] range, particularly given recent heavy construction cost increases. The project costs reflect private sector development.

7. National Economic Development (NED) Impacts/Assets. With Mitigation.

a. Market Based NED Aanalysis.

To convey more accurately the direct irrigation sector economic impacts and a required mitigation strategy, the CSRIA developed a Risk Mitigation Response Alternative (2020). The approach defines the legal, technical, and economic factors that must be fully considered by the CRSO agencies and Washington State elected leadership, under LSR dam breaching and project pool drawdowns.

The ESA-CRSO litigation EIS was authorized via the National Environmental Policy Act and generally followed the Council of Environmental Quality Regulations for EIS preparation.[14] Within the EIS, the agencies must assess appropriate mitigation measures for the proposed action or other EIS alternatives.[15] Benefit-cost analyses are optional for inclusion in an EIS, but in the case of major, federal water resources actions, B-C analyses are almost always prepared. Such economic analyses incorporate the direct economic costs for mitigation measures.

Authorized under Washington State's 2019 operations budget,[16] the legislature allocated $750,000 for the Governor's Office to *"contract with a neutral third party to establish a process for local, state, tribal, and federal leaders and stakeholders to address issues associated with the possible breaching or removal of the four Lower Snake River dams in order to recover the Chinook salmon populations that serve as a vital food source for southern resident orcas."*

In 2023, further review was authorized by the legislature to review the irrigation sector economic costs of dam breaching, and ways to avoid or limit impacts. The risk mitigation impact method employed by CSRIA follows three basic principles:

1. The concepts and analyses for Irrigation Sector direct economic impacts, with inherent mitigation measures, should be modeled on well-established principles for federal water resources

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[13] Recent estimates by USBR for this type of construction exceed $1 billion.

[14] NEPA, Pub.L. 91-190, 24 U.S.C. 4321-4347, as amended 1970, 1975, 1982; CEQ Regulations 2005, and October 10, 2019, Title 40 Protection of the Environment, Part 1502—Environmental Impact Statement.

[15] Providing mitigation plans under NEPA/EIS frameworks is applied as standard practice, for example, see NOAA, U.S. Dept. of Commerce, "Guidelines and Principles for Social Impact Assessment," NOAA Interagency Committee, May 1994; and CSRIA Representatives note that virtually all EIS preparation handbooks elaborate on defining mitigation measures for proposed alternatives.

[16] House Appropriations Committee, Operations Budget, ESHB 1109, Section 118; and see Southern Resident Orca Task Force, "Report and Recommendations," November 2018, November 2019.

management. This standard should incorporate direct net value changes to water distribution and land assets, predicated on observable, market-based determinations for willingness-to pay.

2. The direct economic impacts must be defined based on market asset values for the irrigated land impacts, taking into account pump station modifications, loss of production, and on-site processing infrastructure. The dam breaching-pool drawdown actions would create a "distressed asset value" that must be the foundation for EIS/State study impacts and mitigation compensation.

3. The primary Irrigation Sector impacts can be measured through recent asset-based market transactions and the market perception toward risks associated with distressed asset values. The asset market reflects the private, corporate, and institutional entities that have made recent market purchases, and those entities who have an ability and desire to expand farm asset operations.

The direct economic value baseline for the affected irrigated acres is well known, and it is the market asset value displayed through irrigated land purchases and sales.[17] These transactions take into account the full land asset value for pump stations, agricultural production, and on-site processing facilities serving irrigation operations. The values also reveal the market's true accounting for real irrigated land escalation rates and future terminal values, that are not captured in conventional lenders' enterprise/production budget calculations.[18] This full market valuation factor is extremely important to the privately held farming operations along the pools, as these lands are perhaps the most desired irrigation holdings in the Western U.S.[19]

In Table 3 attached, the more recent land/asset value sales are displayed for the farming operations served by the Ice Harbor, McNary, and John Day pools. This sales information is accumulated from County Assessor land transaction and taxation data bases, private realty land value data bases, CSRIA members' comparable land sales information, and land sales contracts reviewed by CSRIA representatives. This information covers the 2016-2018 and 2020-2023 periods.

To provide a single asset value estimate, in dollar value per acre terms, the 2016-2018 land asset sales data have been weighted by acres for the direct sales involved, and then adjusted to reflect the current acreage mix for tree fruit-grape production versus field-row crop production. This yields an "average" asset value of about $16,400/acre, relevant to the primary impact acres (92,500 acres). Since 2018, two additional land sales pertinent to this market assessment occurred in 2020-2023, for about $16,500/acre and $16,700/acre. As such, the overall valuation per acre is determined to be about $16,500/acre (2021$).[20]

In total, the baseline, primary asset value is about $1.526 billion. This serves as the baseline value from which to estimate the risk mitigation value affecting the primary impact acres.

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[17] In more technical terms, the market value is equivalent to the capitalized value of the annual income streams to ownership and management over time, discounted to present value dollars. This market value is the direct economic value that should be applied to National Economic Development accounting. Changes in direct net economic value form the basis for federal water resources benefit/cost analyses, for river management impacts.

[18] The irrigated land enterprise/production budgets used by the USBR to measure direct net value are inadequate to measure the full asset values of irrigated land, for high quality, 21st Century irrigated farming operations.

[19] There is strong market demand for all the Columbia-Snake River direct-pumper farms, with the CSRIA regularly contacted for land market availability.

[20] The 2018-2021 national Agricultural lands sales values display little change, NASS Data, 2023.

Subject to dam breaching, the risk impacts create a "distressed asset value" that is best estimated by the market. In this circumstance, the market is composed of the individual land holdings owners and farm mangers who have written the checks to acquire the existing assets, and they are actively engaged in the market to purchase additional holdings where opportunities emerge. Most of these market entities are CSRIA members.

The calculation of the distressed market is made by how the market discounts the asset value given the dam breaching-pool drawdown risks. These risks include intake and pump station rebuilding costs, lost production income during the initial breaching/drawdown phase, stranded asset costs for on-site processing facilities, and potential market losses or reintroduction costs with product buyers. The question becomes, if the breaching/drawdown action is known to happen today, how does that affect the baseline asset value? How much would the new distressed asset value be worth? What would be the market's new willingness-to-pay to acquire the subject land assets?

A structured ranking question was posed to individual market entities (12 separate entities), and again collectively to the CSRIA Board of Directors, identifying land asset discounting ranges (90% to "no sale'), where the entities had cash-in-hand or financing preapproval for new purchases. The market entities provided a consistent asset (capital) discount rate of 30-50% (two entities replied "no sale"). In effect, the market would not reject the land assets for new purchase, but the market entities would substantially reduce the asset value of the land holdings, confronted with the risk surrounding many unknown costs.

The breaching/drawdown risk deflates the asset holdings. The difference between the asset value baseline and the distressed asset value level establishes the amount of the risk mitigation response required for Irrigation Sector compensation. Allocated for each pool, the risk mitigation value is:

- Ice Harbor Pool, 30-50% distressed asset value: $271,260,000--$452,100,000.
- Upper McNary Pool, 30% distress asset value: $306,900,000.

This risk mitigation response estimate establishes a benchmark compensation value at about $578,160,000 to $759,000,000. This is the "average" compensation value required to bring the irrigation sector back to a baseline, market-based value level of $16,500 per acre, for 92,500 acres.

. **b. Risk Mitigation Compensation.**

The risk mitigation response alternative includes obligations by the irrigation sector and a capital repayment structure that equitably assigns mitigation costs. The irrigation sector would be responsible for pump station and infrastructure modifications, incurred agricultural production costs, and disrupted market functions. The Bonneville Power Administration and Washington State would be responsible for up-front mitigation payments to the Irrigation Sector.

Compensation to injured parties by those holding liability is a normative legal standard[21] and is implicitly expressed in EIS mitigation alternatives. This standard applies more cogently, where intent is premeditated or is part of an agency action that benefits some broad societal objective at the expense of select parties. In

[21] For example, see Steven Shavell, "Foundations of Economic Analysis of Law," Fellows of Harvard College, Harvard University Press, 2004.

this case, the irrigation sector is the party to be compensated for injuries, and the social liability payments are best compensated through the Bonneville Power Administration (BPA) and the state of Washington.

The Irrigators can be unequivocally recognized as the affected (injured) party, they must bear the costs of changes to river operations that impair irrigation water pumping. The BPA has received power benefits from the hydro projects, distributed throughout the Western States, and it is responsible for fish mitigation costs under the Northwest Power Act of 1980. The state of Washington has received significant economic benefits from the Lower Snake River-Columbia system irrigation projects, including direct and secondary impacts from income, employment, and taxation. These statewide benefits should now engender some degree of liability for the Irrigation Sector impacts, and for continued contribution to the state economy and tax structure.[22]

Under a shared compensation responsibility, the BPA and Washington State would need to borrow about $578,160,000--$759,000,000 to provide up-front capital payments, for risk mitigation response compensation. If borrowed from long-term Federal Treasury debt and state General Obligation capital bonding sources, the annualized BPA and State debt repayments would be approximately:

- Bonneville Power Administration (T-bonds), $289--379 million: $17.6—23.5 million annually.
- Washington State (General Obligation Bonds), $289--379 million: $17.6--$23.5 million annually.

Using the above benchmark estimates for risk mitigation response, the total annual irrigation sector cost for debt repayment would be about $35 to $47 million.[23]

Receiving the risk mitigation response compensation, the Irrigation Sector would be responsible for pump station and infrastructure modifications, incurred agricultural production income losses, and impaired market functions. All these obligations would be incurred by the private sector irrigators.

8. Regional Economic Development (RED) Impacts.

While economists prefer measures of direct (NED) value for determining net social welfare benefits (or costs), most state and regional decision makers prefer "local" impact estimates (RED) expressed as regional household income or employment. The preferred estimate provided here is annual household income impacts, across the 92,500 acres within the project area. The estimates are principally based on income estimates derived from the agricultural production, agricultural services, and food processing sectors (direct) and linked to income estimates from associated indirect and induced purchases made from other sectors (secondary impacts). This series of product sales (output) and purchases (inputs) create inter-sector income throughout the regional economy.

These income estimates can be calculated using independent input-output models (IMPLAN) or income data/models from the U.S. Bureau of Economic Analysis (BEA multipliers).[24] The INPLAN model and BEA

[22] The State (legislature/Governor Inslee) also assumes some inescapable liability by requesting dam breaching studies.

[23] Payment amortization at 30-years with a 4.5% bonding interest rate.

[24] IMPLAN is a private sector economic model with cloud-based access/structure https://implan.com/company/. BEA models and multipliers may be reviewed/obtained on a government website referred to as BEARFACTS, https://apps.bea.gov/regional/bearfacts/. Modification of the multipliers is made by CSRIA, per discussion with BEA

model estimates can be very similar depending on data and assumptions used for both. They both depict a "spreadsheet" of the regional economy containing the numerous linkages between economic sectors. Both model estimates are reported in Table _ , as prepared by the USBR (2020 EIS) and CSRIA.

The RED estimates for the project area suggest significant contributions to regional household income. The USBR and BEA estimates are congruent, suggesting an annual income contribution range of about $4,870 to $5,020 per acre. In total, this amounts to about $450 to $464 million annually. The closeness of the range also suggests reliability of the estimates for the policy-based objective of this review.

Table 2. Estimated Regional Economic Development-Household Income Impacts

Regional Income Model-Sectors	Acres	Annual Income/Acre Estimated 2021$	Total Annual Income 2021$
Ice Harbor Pool USBR INPLAN Model	48,999	$5,020	$245,683,000
Ice Harbor-Upper McNary Pools-USBR INPLAN Model*	92,500	$5,020	$464,350,000
WA State Irrigated Ag. Estimate BEA Data-Multipliers	1,850,000	$4,870	$9,005,800,000
Project Area Irrigated Ag. Estimate BEA Data-Multipliers**	92,500	$4,870	$450,475,000
Regional Irrigated Ag. Estimate-NASS-BEA-Data-Mult.***	92,500	$4,280	$394,000,000

Sources: U.S. Army Corps of Engineers, Bonneville Power Administration, U.S. Bureau of Reclamation, "Columbia River System Operations EIS," Portland, OR, 2020, Appendix N Water Supply Impacts.
NASS and Bureau of Economic Analysis Data from Table 4.
BEA Multiplier Estimates from RIMS II Data-Model Sets with Adjustments by CSRIA (see Table 4).
*INPLAN Model estimates carried forward to adjacent crop production estimates below Ice Harbor Pool given similar crop mix for high-value crop production (potatoes, alfalfa, tree fruit, other).
**BEA Data-Multiplier estimates rely on percentage estimates for irrigated acres income, for state-wide impacts, minus cattle production income (estimated at 30% of total income, per 2021 production value).
***BEA income data estimate based on direct economic sectors, Production Agriculture, Ag. Services, Food Processing sectors, with indirect income multiplier (combined sectors) at 1.90, per statewide estimate in Appendix Table . Estimated direct income based on irrigation acreage percentage of project area counties, that exclude income within Benton County and other areas serving the project. Estimate should be considered preliminary.

When the direct model sectors--agricultural production, services, and food processing--are aggregated, forming the "Irrigated Agricultural Industry," income (or value added) multipliers usually fall within the 2.0-2.5 range.[25] The multiplier estimate used here is calculated as 1.9 applied to the secondary economic sectors.

models, to avoid double counting of income impacts between sectors (based on final demand contributions by sector). For example, the agricultural production sector multiplier for income earnings is reduce by about 50% to avoid double counting with the food processing sector.

[25] Pacific NW Project, "Western Irrigated Agriculture Economic Impacts," White Paper Prepared for the Family Farm Alliance, Kennewick, for service to the USBR commissioner, WA 2015; Pacific NW Project, "Southeastern Idaho Water Resources Management Impacts, A Policy White Paper Review," Prepared for the Bingham, ID, Groundwater District for service to the Idaho Department of Water Resources, technical hearings, January and June 2023, Kennewick, WA.

9. What Cannot Be Mitigated, What Can Be Mitigated.

a. Development Timelines.

As noted above, being able to complete irrigation pump station reconstruction, without some loss to irrigation season(s) pumping will not likely be feasible given multiple timing factors affecting dam breaching and pool drawdowns, and integrating this development schedule with pump station reconstruction, for either pump station-by-pump station work or for a regional pipeline approach. It is estimated that from design to reconstruction development will require 2-4 years (at best), and disruption to some irrigation pumping will likely fall within a (minimal) 1-2 year period. Even these timing estimates may be overly optimistic.

10. Regional Impact Mitigation.

Attempting to mitigate for regional household income impacts for the direct, indirect, and induced economic sectors will be next to impossible. At best, the risk mitigation alternative may be the most optimal manner to provide some degree of income compensation to the farm operators and some farm employees. This compensation would include payment for private sector reconstruction for the pump stations, directly implemented by the farm/asset owners (all private sector reconstruction).

11. Further Consideration for the Pipeline Implementation.

The Franklin Conservation District and CSRIA have only preliminarily discussed above a pipeline implementation approach to serving the Ice Harbor and Upper McNary Pools pump stations, under LSR dam breaching conditions. This type of approach carries with it much different reconstruction needs and timing than that contemplated by pump station-to-pump station modifications. The District and CSRIA have some approaches, or potential alternatives, that likely differ from that currently be considered by the USBR. The state would likely benefit from pursuing further review work with the District and CSRIA to better understand these alternatives.

ATTACHED TABLES AND MAPS

Table 3. Land/Production Asset Market Sales Values.

For Ice Harbor, McNary, and John Day Pools 2016-2019, and with 2021-2023 Sales.

Columbia-Snake R. Project Pools*	**Approximate Irrigated Acres**	**Sale Composition**	**Est. $/Acre 2018$**
Ice Harbor Pool-R	2,200	Pumps/System/Land (Equipment)	$14,500
Ice Harbor Pool-R	2,200	Pumps/System/Land (Equipment)	$11,700
Ice Harbor Pool-T/V	510	Pumps/System/Land (Contract Bid)	$17,800
Ice Harbor Pool-T/V	6,200	Pumps/System/Land Processing, Other	$23,000
Ice Harbor Pool-R	1,250	Pumps/System/Land Processing, Other	$20,100
John Day Pool-R	13,500	Pumps/System/Land (Equipment)	$13,000
John Day Pool-T/V	20	Pumps/System/Land	$21,100
McNary Pool-T/V	150	Pumps/System/Land	$30,000
McNary Pool-R	130	Pumps/System/Land	$17,600
McNary Pool-R	160	Pumps/System/Land	$10,500
Transaction Acres:	26,320	Weighted Ave. $/Acre:	$15,900
		Adjusted Ave. $/Acre: For Site Crop Types	**$16,400**
McNary Pool (2021$)	**12,400**	Pumps/System/Land	**$16,500**
John Day Pool (2023$)	**2,640**	Pumps/System/Land and Additional Water	**$16,950**

Sources: Benton, Franklin, Walla Walla Counties' Assessor Offices, Taxation and Sales Web Site Data 2019; Acre Value Google Website, WA Land Sales and Prices for Benton, Franklin, and Walla Walla Counties, September 2019; CSRIA Board Member Land Valuation Comparables Appraisal; Personal Communications with CSRIA Members (land sales); and CSRIA Representative Review of Selected Land-Water Purchase and Sales Agreements (2017-2019); 2021 and 2023 Sales Data from CSRIA Representatives and Members.

* T/V = Trees/Vineyards; R = Row or Field Crops.

Table 4. The Irrigated Agriculture Industry—Real Dollar Meaning

State water policy governing the Irrigated Agriculture Industry has "real dollar meaning" to the economic life of Eastern WA and state citizens. It drives the future for irrigators, laborers, managers, scientists, entrepreneurs, manufacturers, and suppliers working directly within the Industry and to the thousands of people who sustain support services and community needs.

Political leaders' water policy directives become agency actions, with agency staff interpreting statutes and administrative rules "to fit" the policy objectives. Those in the Industry say that political leaders should recognize the economic prevalence already in-hand and be working with Industry representatives to shape the future, not just react to it. Basic water supplies for irrigation are far more stable in Eastern WA than most other areas of the Western U.S. That puts the state in a unique position to further grow real dollar economic benefits.

Washington State Irrigated Agriculture Industry[26]
Estimated Annual Household Income Value, 2021$

Industry Sector	Estimated % Irr. Ag.	Direct 2021$ Earnings/Income	Indirect/Induced Multiplier Impact	Estimated Total Impact 2021$
Direct Irr. Ag. Production	85%	$2,719,150,000	1.49	$4,051,534,000
(Crops and Cattle)				
Ag. Services	75%	$1,025,250,000	1.16	$1,189,290,000
(Non-Forestry-Irr. Ag.)				
Food Processing/Manuf.	90%	$2,569,500,000	2.60	$6,680,700,000
(Irr. Ag. Products)				
Beverages	60%	$429,600,000	2.20	$945,120,000
(Irr. Ag. Products)				
TOTAL:		**$6,743,500,000**		**$12,866,640,000**

[26] **The Irrigated Agriculture Industry:** is comprised of the direct irrigated farm production, agricultural services (includes some crop/food packaging), and the food processing and manufacturing sectors. The non-irrigated Ag. sector is excluded. Impact multipliers applied here are adjusted to avoid inter-sector double counting.

Analysis Sources include: USDA, National Agricultural Statistical Services (NASS), 2017-2018 Market Value Production Estimates and Irrigation Survey, Census of Agriculture, WA; NASS, Washington State Production Data, 2020, Statistical Bulletin, Production and Value Series, 2022; U.S. Bureau of Economic Analysis, Personal Income by Major Industry (NAICS) Data Tables WA 2021 Estimates (Earnings/Income); U.S. Bureau of Economic Analysis Regional Economic Impacts Tools, Regional Input-Output Inter-Industry Modeling and Regional I/O Model Multiplier Estimates (Income/Employment) for WA and Central WA Counties, BEARFACTS; Inter-Industry Final Demand/Requirements Linkages for 2012 with 2020 Data Estimates.

Note: Impact estimates reflect broad sector impacts and are not specific to any independent project or sub-industry sector. Estimates prepared by the Pacific NW Project and are considered conservative and reliable for policy-based alternatives and decisions affecting WA State Irrigated Agriculture. Further information may be obtained by contacting CSRIA representatives at 509-783-1623 or CSRIA.org.

Table 5. Risk Mitigation Asset Values

Market-Based Determinations for Baseline Values and Impacts

Columbia-Snake R. Project Pools*	Approximate Irrigated Acres	Ave. Land Asset Value $/Acre 2018$	Total Impact Area Baseline Asset Value
Ice Harbor Pool	54,900	------	------
Upper McNary Pool	37,600	------	------
Total Acres/Asset Value	92,500	$16,500	$1,526,250,000
Distressed Assets	**Market Based**		
Impact Value by Pool	**Estimated Impact**	**Value of Distress Assets**	**Total**
Ice Harbor Pool	30%	$271,260,000	------
	50%	$452,100,000	------
Upper McNary Pool	30%	$306,900,000	------
		Total Distressed Asset:	$578,160,000
			$759,000,000
			Annual Long-Term Dept
	Shared Payment Level	**Capital Asset Liability**	**Repayment Liability***
Distressed Assets	Bonneville Power Admin. 50%	$289 to $379 Million	$17.6 to $23.5 Million
Capital Repayments	State of WA 50%	$289 to $379 Million	$17.6 to $23.5 Million
			Total
			$35 to $47 Million

Sources: Market-Based Distressed Values estimated by current land sales purchasers and active market participants,

CSRIA members and CSRIA Representatives.

* Assumes BPA financial obligation tied to long-term Federal Treasury Bonds (or similar debt), and long-term WA State general

obligation bonds. A "mixed" interest/discount rate of 4.5% annually is applied to the above financing assumptions.

Table 6. Irrigated Crops – Total, Above Ice Harbor Pool, and McNary Pool

Irrigated Crops within Area of Interest/Impact	
Crop Type	Acres
Potato	20,017
Apple	13,877
Corn, Field	12,896
Wheat	11,828
Corn, Sweet	11,345
Alfalfa Hay	4,825
Onion	2,897
Pea, Green	2,357
Carrot	1,255
Cherry	1,232
Pasture	1,166
Grass Seed	1,115
Fallow, Tilled	1,030
Timothy	1,017
Bean, Dry	973
Grape, Juice	749
Blueberry	712
Wildlife Feed	549
Mint	437
Fallow, Idle	424
Grape, Wine	253
Pea, Dry	233
Garlic	225
Canola	203
Asparagus	190
Corn Seed	138
Barley	136
Wheat Fallow	112
Grass Hay	88
Cover Crop	50
Developed	40
Filbert	34
Pea Seed	27
Alfalfa/Grass Hay	21
Unknown	9
Fallow	3
Market Crops	2
Caneberry	1
Kiwi	1
Nectarine/Peach	1
Grand Total	**92,468**

Irrigated Crops within Area of Interest/Impact Above Ice Harbor Dam	
Crop Type	Acres
Potato	11,455
Corn, Field	9,651
Apple	8,855
Wheat	7,897
Corn, Sweet	5,358
Onion	2,265
Pea, Green	1,690
Alfalfa Hay	1,236
Carrot	1,140
Pasture	817
Grass Seed	685
Grape, Juice	647
Cherry	558
Wildlife Feed	549
Fallow, Tilled	369
Mint	329
Pea, Dry	233
Canola	203
Grape, Wine	147
Timothy	140
Corn Seed	138
Wheat Fallow	112
Grape, Wine	104
Fallow, Idle	102
Grass Hay	81
Filbert	34
Pea Seed	27
Cover Crop	18
Fallow	3
Grand Total	**54,843**

Irrigated Crops within Area of Interest/Impact McNary Pool	
Crop Type	Acres
Potato	8,562
Corn, Sweet	5,987
Apple	5,022
Wheat	3,931
Alfalfa Hay	3,589
Corn, Field	3,245
Bean, Dry	973
Timothy	877
Blueberry	712
Cherry	674
Pea, Green	667
Fallow, Tilled	661
Onion	632
Grass Seed	430
Pasture	349
Fallow, Idle	322
Garlic	225
Asparagus	190
Barley	136
Carrot	115
Mint	108
Grape, Juice	102
Developed	40
Cover Crop	32
Alfalfa/Grass Hay	21
Unknown	9
Grass Hay	7
Grape, Wine	2
Market Crops	2
Kiwi	1
Caneberry	1
Nectarine/Peach	1
Grand Total	**37,625**

Table 7. Franklin County Irrigated Crops – Total, Above Ice Harbor Pool, and McNary Pool

Franklin County Irrigated Crops within Area of Interest/Impact

Crop Type	Acres
Potato	4,611
Apple	3,292
Wheat	2,662
Corn, Sweet	2,068
Corn, Field	1,815
Onion	1,315
Pea, Green	738
Fallow, Tilled	605
Grass Seed	576
Cherry	495
Blueberry	439
Wildlife Feed	395
Alfalfa Hay	259
Pea, Dry	233
Canola	203
Wheat Fallow	112
Grape, Wine	104
Grass Hay	81
Pasture	79
Fallow, Idle	37
Filbert	34
Pea Seed	27
Alfalfa/Grass Hay	21
Developed	20
Timothy	18
Fallow	3
Grand Total	**20,242**

Franklin County Irrigated Crops within Area of Interest/Impact Above Ice Harbor Dam

Crop Type	Acres
Potato	2,805
Wheat	2,193
Apple	1,729
Corn, Field	1,685
Corn, Sweet	1,219
Onion	1,076
Pea, Green	738
Grass Seed	576
Wildlife Feed	395
Alfalfa Hay	241
Pea, Dry	233
Canola	203
Cherry	193
Wheat Fallow	112
Grape, Wine	104
Grass Hay	81
Pasture	41
Fallow, Idle	37
Filbert	34
Pea Seed	27
Timothy	18
Fallow	3
Grand Total	**13,743**

Franklin County Irrigated Crops within Area of Interest/Impact McNary Pool

Crop Type	Acres
Potato	1,806
Apple	1,563
Corn, Sweet	849
Fallow, Tilled	605
Wheat	469
Blueberry	439
Cherry	302
Onion	239
Corn, Field	130
Pasture	38
Alfalfa/Grass Hay	21
Developed	20
Alfalfa Hay	18
Grand Total	**6,499**

Table 8. Walla Walla Irrigated Crops – Total, Above Ice Harbor Pool, and McNary Pool

Walla Walla County Irrigated Crops within Area of Interest/Impact

Crop Type	Acres
Potato	15,406
Corn, Field	11,081
Apple	10,585
Corn, Sweet	9,277
Wheat	9,166
Alfalfa Hay	4,566
Pea, Green	1,619
Onion	1,582
Carrot	1,255
Pasture	1,087
Timothy	999
Bean, Dry	973
Grape, Juice	749
Cherry	737
Grass Seed	539
Mint	437
Fallow, Tilled	425
Fallow, Idle	387
Blueberry	273
Garlic	225
Asparagus	190
Wildlife Feed	154
Grape, Wine	149
Corn Seed	138
Barley	136
Cover Crop	50
Developed	20
Unknown	9
Grass Hay	7
Market Crops	2
Caneberry	1
Kiwi	1
Nectarine/Peach	1
Grand Total	**72,226**

Walla Walla County Irrigated Crops within Area of Interest/Impact Above Ice Harbor Dam

Crop Type	Acres
Potato	8,650
Corn, Field	7,966
Apple	7,126
Wheat	5,704
Corn, Sweet	4,139
Onion	1,189
Carrot	1,140
Alfalfa Hay	995
Pea, Green	952
Pasture	776
Grape, Juice	647
Fallow, Tilled	369
Cherry	365
Mint	329
Wildlife Feed	154
Grape, Wine	147
Corn Seed	138
Timothy	122
Grass Seed	109
Fallow, Idle	65
Cover Crop	18
Grand Total	**41,100**

Walla Walla County Irrigated Crops within Area of Interest/Impact McNary Pool

Crop Type	Acres
Potato	6,756
Corn, Sweet	5,138
Alfalfa Hay	3,571
Wheat	3,462
Apple	3,459
Corn, Field	3,115
Bean, Dry	973
Timothy	877
Pea, Green	667
Grass Seed	430
Onion	393
Cherry	372
Fallow, Idle	322
Pasture	311
Blueberry	273
Garlic	225
Asparagus	190
Barley	136
Carrot	115
Mint	108
Grape, Juice	102
Fallow, Tilled	56
Cover Crop	32
Developed	20
Unknown	9
Grass Hay	7
Grape, Wine	2
Market Crops	2
Kiwi	1
Caneberry	1
Nectarine/Peach	1
Grand Total	**31,126**

Table 9. Irrigated Water Rights within the Impacted Area

Water Right Number	Water Right Type[1]	Instantaneous Amount (Qi)	Annual Volume (Qa)	Irrigated Acres	Instantaneous Unit	Purpose Of Use	Source
S3-00812C	CE	125	21,000	7,000	CFS	IR	surfaceWater
S3-20371C	CE	84	15,673	4,514	CFS	IR	surfaceWater
S3-01062C	CE	30	18,000	4,500	CFS	IR	surfaceWater
SWC11862	CE	63	15,916	3,979	CFS	IR	surfaceWater
S3-22838C(A)	CE	87	18,191	3,912	CFS	IR	surfaceWater
SWC10703	CE	80	23,121	3,303	CFS	IR	surfaceWater
S3-*18108C	CE	37	8,532	2,942	CFS	IR	surfaceWater
S3-01503C	CE	44	5,138	2,492	CFS	IR	surfaceWater
S3-21044(C)	CE	58	11,320	2,435	CFS	IR	surfaceWater
S3-*28646J	CE	64	12,000	2,400	CFS	IR IR IR	surfaceWater
S3-22228(A)SC	CE	36	11,531	2,200	CFS	IR	surfaceWater
S3-01599CWRIS	CE	27	6,465	2,155	CFS	IR	surfaceWater
S3-21045C	CE	42	7,628	1,907	CFS	IR	surfaceWater
S3-24501C	CE	30	8,370	1,800	CFS	IR	surfaceWater
S3-01593C	CE	30	7,212	1,379	CFS	IR	surfaceWater
SWC09252	CE	40	8,850	1,319	CFS	IR	surfaceWater
S4-01351(A)C	CE	15	3,282	1,231	CFS	IR	surfaceWater
S3-01180CWRIS	CE	17	4,102	1,111	CFS	DS ST IR	surfaceWater
S3-21044C(B)	CE	22	4,314	928	CFS	IR	surfaceWater
S3-21433APCWRIS	CE	17	3,072	920	CFS	IR	surfaceWater
S3-24719C	CE	19	3,340	835	CFS	IR	surfaceWater
S3-21433C(B)	CE	13	2,632	788	CFS	IR	surfaceWater
S3-24274C	CE	14	3,515	756	CFS	IR	surfaceWater
S3-21044(A)	CE	16	3,134	674	CFS	IR	surfaceWater
S3-22228(B)SC	CE	10	3,145	600	CFS	IR	surfaceWater
S3-01602C	CE	11	2,180	545	CFS	IR	surfaceWater
S3-26448C	CE	13	1,948	487	CFS	IR	surfaceWater
S3-24806C	CE	9	2,516	480	CFS	IR	surfaceWater
S3-*20260BPCWRIS	CE	7	1,864	466	CFS	IR	surfaceWater
S3-26000C(A)	CE	9	1,810	453	CFS	IR	surfaceWater
S3-28993C	CE	3	733	450	CFS	HP FP IR	surfaceWater
S3-26139C	CE	8	2,250	450	CFS	IR	surfaceWater
S3-01486C	CE	9	2,202	420	CFS	IR	surfaceWater
S3-26230C	CE	12	1,680	420	CFS	IR	surfaceWater
S3-22228(C)SC	CE	7	2,097	400	CFS	IR	surfaceWater
S3-24273C	CE	7	1,860	399	CFS	IR	surfaceWater

S3-00334C	CE	8	1,185	395	CFS	IR	surfaceWater
S3-22838C(B)	CE	9	1,802	388	CFS	IR	surfaceWater
S3-29063C	CE	14	1,606	384	CFS	FP IR IR	surfaceWater
S3-25062C	CE	9	1,834	350	CFS	IR	surfaceWater
S3-26503C	CE	9	672	336	CFS	IR	surfaceWater
S3-28015C	CE	7	1,488	320	CFS	IR	surfaceWater
S3-23526C	CE	5	1,225	320	CFS	IR	surfaceWater
S3-24558C	CE	2	1,221	300	CFS	IR	surfaceWater
S3-21433(C)C	CE	5	990	296	CFS	IR	surfaceWater
S3-26000C(B)	CE	5	1,110	278	CFS	IR	surfaceWater
S3-25127C	CE	6	1,310	250	CFS	IR	surfaceWater
S3-28723C	CE	6	996	249	CFS	IR	surfaceWater
S3-20478C	CE	4	1,048	200	CFS	IR	surfaceWater
S4-01335(C)C	CE	3	527	195	CFS	IR	surfaceWater
S3-24580C	CE	4	794	171	CFS	IR	surfaceWater
S3-28177C	CE	4	668	167	CFS	IR	surfaceWater
S3-26456C	CE	4	415	166	CFS	IR	surfaceWater
S3-01483C	CE	4	839	160	CFS	IR	surfaceWater
S3-24882C	CE	4	640	160	CFS	IR	surfaceWater
S3-01370C	CE	4	828	158	CFS	IR	surfaceWater
S3-27096C	CE	3	620	155	CFS	IR	surfaceWater
S3-26492C	CE	3	244	150	CFS	IR	surfaceWater
S3-21433(E)C	CE	3	495	148	CFS	IR	surfaceWater
S3-21433(D)C	CE	2	495	148	CFS	IR	surfaceWater
S3-25420C	CE	3	420	120	CFS	IR	surfaceWater
S3-27433C	CE	3	400	100	CFS	IR	surfaceWater
S3-26490C	CE	2	162	81	CFS	IR	surfaceWater
S3-24667C	CE	2	419	80	CFS	IR	surfaceWater
S3-22263CWRIS	CE	1	372	80	CFS	IR	surfaceWater
S3-25101C	CE	2	393	79	CFS	IR	surfaceWater
S3-25427C	CE	2	300	75	CFS	IR	surfaceWater
SWC07981	CE	1	296	74	CFS	IR	surfaceWater
S3-24583C	CE	2	329	71	CFS	IR	surfaceWater
S3-20829C	CE	2	325	70	CFS	IR	surfaceWater
S3-28188C	CE	1	325	70	CFS	IR	surfaceWater
S3-27901C	CE	1	280	70	CFS	IR	surfaceWater
S3-20916C	CE	2	304	65	CFS	FP ST IR	surfaceWater
SWC07056	CE	1	196	49	CFS	IR	surfaceWater
S3-25193C	CE	1	225	43	CFS	IR	surfaceWater
S3-24898C	CE	1	210	40	CFS	IR	surfaceWater
S3-20479C	CE	1	199	38	CFS	IR	surfaceWater

S3-23611C	CE	1	144	31	CFS	IR	surfaceWater
S3-20763C	CE	1	144	31	CFS	IR	surfaceWater
SWC03939	CE	1	0	27	CFS	IR	surfaceWater
S3-25086C	CE	0	104	20	CFS	IR	surfaceWater
SWC03241	CE	0	0	17	CFS	IR	surfaceWater
SWC05191	CE	0	0	1	CFS	FR IR	surfaceWater
SWC11865	CE	18	13,292	*	CFS	IR	surfaceWater
S3-*21411C	CE	14	8,532	*	CFS	IR	surfaceWater
S3-24900C	CE	44	4,984	*	CFS	IR	surfaceWater
S3-*21411CPCWRIS	CE	3	1,558	*	CFS	IR	surfaceWater
S3-162377CL	CL	4	1,340	700	CFS	IR	surfaceWater
S3-24704	PE	225	43,704	10,926	CFS	IR	surfaceWater
S3-28903P	PE	50	9,253	1,990	CFS	IR	surfaceWater
S3-28907	PE	12	3,911	1,054	CFS	IR	surfaceWater
S3-27891(A)	PE	5	852	213	CFS	IR	surfaceWater
S3-27891(B)	PE	3	508	127	CFS	IR	surfaceWater
G3-CV1-3P494	CC	2,170	660	165	GPM	IR	groundwater
CCVOL2-3P13	CC	1,200	744	160	GPM	IR	groundwater
G3-00216(CCVOL1-3P292)SC	CE	1,200	1,440	840	GPM	IR	groundwater
G3-22873C	CE	5,000	3,458	660	GPM	IR	groundwater
G3-26487C	CE	4,185	2,560	640	GPM	IR	groundwater
GWC06962(CCVOL1-3P290)-ASC	CE	1,200	962	610	GPM	IR	groundwater
G3-28146C	CE	5,000	2,790	600	GPM	IR	groundwater
G3-29364(A)	CE	5,104	2,735	547	GPM	IR	groundwater
G3-26485C	CE	4,320	2,132	533	GPM	IR	groundwater
G3-00942C	CE	4,500	2,500	500	GPM	IR	groundwater
G3-*08350ALCWRIS	CE	350	467	500	GPM	IR	groundwater
G3-27934SC	CE	3,000	2,320	499	GPM	IR	groundwater
G3-01349C	CE	4,500	2,588	495	GPM	IR	groundwater
G3-28160C	CE	2,500	1,680	480	GPM	IR	groundwater
G3-28992C	CE	760	1,216	450	GPM	IR IR HP FP DS FP HP	groundwater
G3-27933SC	CE	2,500	1,860	375	GPM	IR	groundwater
G3-27932SC	CE	2,300	1,711	368	GPM	IR	groundwater
G3-27839	CE	3,000	1,396	365	GPM	IR	groundwater
G3-22242C	CE	2,000	1,325	285	GPM	IR	groundwater
G3-29240	CE	3,500	1,209	250	GPM	IR FP	groundwater
G3-28463C	CE	950	1,520	240	GPM	CI IR	groundwater

G3-26527C	CE	1,500	1,600	240	GPM	CI IR	groundwater
G3-*07696C	CE	960	900	225	GPM	IR	groundwater
G3-27804	CE	2,250	975	225	GPM	IR	groundwater
G3-28626C	CE	400	66	194	GPM	FP IR	groundwater
G3-28683C	CE	2,500	883	190	GPM	IR	groundwater
G3-*04681C	CE	800	684	171	GPM	IR	groundwater
G3-20251C(B)	CE	1,535	704	167	GPM	IR	groundwater
G3-26504GWRIS	CE	2,170	660	165	GPM	IR	groundwater
G3-21039C	CE	1,300	744	160	GPM	IR	groundwater
G3-29363	CE	2,500	680	160	GPM	IR	groundwater
G3-27940C	CE	1,200	744	160	GPM	IR	groundwater
G3-29438	CE	2,000	680	160	GPM	IR IR	groundwater
G3-00401C	CE	1,440	786	150	GPM	IR	groundwater
G3-27906C	CE	450	632	136	GPM	FP IR	groundwater
G3-27470	CE	800	501	131	GPM	IR FP HP	groundwater
G3-25157C	CE	1,300	681	130	GPM	IR	groundwater
G3-24791C	CE	650	623	124	GPM	IR IR	groundwater
G3-28475C	CE	800	460	115	GPM	IR	groundwater
G3-*00949CWRIS	CE	600	420	105	GPM	IR	groundwater
G3-00673C	CE	200	38	100	GPM	IR DG	groundwater
G3-*04517CWRIS	CE	720	400	100	GPM	IR	groundwater
G3-27695C	CE	1,200	380	95	GPM	IR	groundwater
G3-*04097CWRIS	CE	676	425	85	GPM	IR	groundwater
G3-21037C	CE	800	372	80	GPM	IR	groundwater
G3-27897C	CE	750	300	75	GPM	IR	groundwater
G3-*04926CWRIS	CE	550	280	70	GPM	DS IR	groundwater
G3-21936C	CE	530	293	63	GPM	IR	groundwater
G3-21038C	CE	560	279	60	GPM	IR	groundwater
G3-*06588ALCWRIS	CE	300	206	50	GPM	DS ST IR	groundwater
G3-25562C	CE	140	195	42	GPM	IR	groundwater
G3-26088C	CE	350	214	40	GPM	DM IR	groundwater
G3-29364(C)	CE	1,472	144	32	GPM	IR	groundwater
G3-24182C	CE	350	189	30	GPM	DM IR	groundwater
G3-27372(C)	CE	210	120	30	GPM	IR	groundwater
G3-28147C	CE	500	130	28	GPM	IR	groundwater
G3-*02612CWRIS	CE	100	100	25	GPM	ST IR	groundwater
G3-*10988CWRIS	CE	180	129	25	GPM	IR	groundwater
G3-00332C	CE	720	100	24	GPM	IR	groundwater
G3-*03489C	CE	25	35	20	GPM	DM HE FR IR	groundwater
GWC00811-D	CE	350	160	20	GPM	DS IR	groundwater

G3-20662C	CE	750	197	20	GPM	DM IR	groundwater
G3-27921C	CE	120	94	20	GPM	DM IR	groundwater
G3-21573C	CE	160	90	19	GPM	DS ST IR	groundwater
G3-22888C	CE	200	85	18	GPM	DS IR	groundwater
G3-24183C	CE	180	77	16	GPM	DM IR	groundwater
G3-25118GWRIS	CE	200	160	15	GPM	DM FR IR	groundwater
G3-22899C	CE	225	56	15	GPM	DS IR	groundwater
G3-01085C	CE	500	82	15	GPM	DM IR	groundwater
G3-22869C	CE	350	45	12	GPM	DM IR	groundwater
G3-22870C	CE	75	45	12	GPM	DM IR	groundwater
G3-*09879CWRIS	CE	30	24	10	GPM	DS IR	groundwater
G3-22495C	CE	450	48	10	GPM	DM IR	groundwater
G3-*08152CWRIS	CE	200	40	10	GPM	IR	groundwater
G3-*03490CWRIS	CE	100	160	10	GPM	DM HE FR IR	groundwater
G3-28014GWRIS	CE	139	45	10	GPM	DS IR	groundwater
G3-24184C	CE	70	46	9	GPM	DM IR	groundwater
G3-27372(A)	CE	105	30	7	GPM	DS IR ST	groundwater
G3-25013C	CE	140	41	7	GPM	DM IR	groundwater
G3-27372(B)C	CE	35	21	5	GPM	DS IR	groundwater
G3-23640SC	CE	35	26	5	GPM	DS ST IR	groundwater
G3-20697C	CE	60	23	5	GPM	IR	groundwater
G3-*03274CWRIS	CE	20	27	5	GPM	DS ST HE IR	groundwater
G3-23899C	CE	40	27	5	GPM	DM IR	groundwater
G3-24899C	CE	50	19	3	GPM	DS ST IR	groundwater
G3-*06117CWRIS	CE	28	12	3	GPM	DS IR	groundwater
G3-24654C	CE	30	12	3	GPM	DS IR	groundwater
G3-24919C	CE	30	14	3	GPM	DS IR	groundwater
G3-26661C	CE	40	12	2	GPM	DS IR	groundwater
G3-22246C	CE	30	8	2	GPM	DS IR	groundwater
G3-20207C	CE	30	9	2	GPM	DS ST IR	groundwater
G3-23252C	CE	25	8	2	GPM	DM IR	groundwater
G3-*02935CWRIS	CE	30	10	2	GPM	IR	groundwater
G3-28328C	CE	40	11	2	GPM	CI DM IR	groundwater
G3-23615C	CE	14	6	2	GPM	DS IR	groundwater
G3-28219C	CE	30	5	1	GPM	DS IR	groundwater
G3-24633C	CE	25	5	1	GPM	IR	groundwater
G3-00675C	CE	15	4	1	GPM	IR DS ST	groundwater
G3-162380CL	CL	0	0	700	GPM	IR	groundwater
G3-154388CL	CL	2,200	1,000	250	GPM	IR	groundwater

G3-154386CL	CL	1,800	800	200	GPM	IR	groundwater
G3-000511CL	CL	180	5	25	GPM	IR	groundwater
G3-154387CL	CL	200	40	10	GPM	DG IR	groundwater
G3-080236CL	CL	30	8	5	GPM	IR	groundwater
G3-020194CL	CL	60	20	5	GPM	IR	groundwater
G3-009044CL	CL	53	17	5	GPM	DG IR	groundwater
G3-080237CL	CL	30	4	5	GPM	IR	groundwater
G3-011834CL	CL	9	9	4	GPM	IR DG	groundwater
G3-129244CL	CL	32	24	4	GPM	DG IR	groundwater
G3-145469CL	CL	75	14	4	GPM	IR DG	groundwater
G3-014520CL	CL	35	13	3	GPM	IR DG	groundwater
G3-120963CL	CL	30	12	3	GPM	ST IR DG	groundwater
G3-115493CL	CL	25	4	3	GPM	DG ST IR	groundwater
G3-098860CL	CL	25	16	3	GPM	ST IR DG	groundwater
G3-163855CL	CL	28	11	3	GPM	IR DG	groundwater
G3-053218CL	CL	30	10	3	GPM	IR DG	groundwater
G3-051124CL	CL	35	0	2	GPM	DG ST IR	groundwater
G3-146856CL	CL	0	3	2	GPM	DG IR	groundwater
G3-116176CL	CL	20	6	1	GPM	IR ST DG	groundwater
G3-006807CL	CL	4	0	1	GPM	IR DG	groundwater
G3-008446CL	CL	5	6	1	GPM	IR DG	groundwater
G3-118018CL	CL	14	5	1	GPM	ST DG IR	groundwater
G3-012270CL	CL	20	4	1	GPM	IR DG	groundwater
G3-006779CL	CL	4	0	1	GPM	IR DG	groundwater
G3-022815CL	CL	4	0	1	GPM	DG IR	groundwater
G3-022227CL	CL	4	0	1	GPM	IR DG	groundwater
G3-023727CL	CL	4	0	1	GPM	IR DG	groundwater
G3-023547CL	CL	4	0	1	GPM	DG IR	groundwater
G3-116749CL	CL	900	3	1	GPM	DG IR	groundwater
G3-096568CL	CL	0	6	1	GPM	DG IR	groundwater
G3-004317CL	CL	15	4	1	GPM	DG IR ST	groundwater
G3-049148CL	CL	14	4	1	GPM	IR DG	groundwater
G3-055440CL	CL	4	0	1	GPM	DG IR	groundwater
G3-060694CL	CL	4	0	1	GPM	IR DG	groundwater
G3-023726CL	CL	4	0	1	GPM	DG IR	groundwater
G3-005362CL	CL	10	4	0	GPM	IR DG	groundwater

G3-004259CL	CL	15	3	0	GPM	ST IR DG	groundwater
G3-28237P	PE	2,250	2,560	640	GPM	IR	groundwater
G3-28440	PE	4,000	1,866	400	GPM	DM IR	groundwater
G3-28599P	PE	3,400	1,581	340	GPM	IR	groundwater
G3-27029SP	PE	2,700	1,200	300	GPM	IR	groundwater
G3-28078P	PE	1,600	1,395	300	GPM	IR	groundwater
G3-29022P	PE	4,000	985	200	GPM	FP IR	groundwater
G3-*09966	PE	1,600	584	160	GPM	DS IR	groundwater
G3-30812	PE	662	265	125	GPM	IR	groundwater
G3-28860P	PE	1,000	559	120	GPM	IR DG	groundwater
G3-29364(B)	PE	3,200	305	61	GPM	IR	groundwater
G3-29050P	PE	550	219	55	GPM	IR	groundwater
G3-26144	PE	400	160	40	GPM	IR	groundwater
G3-28663	PE	350	140	35	GPM	IR	groundwater
G3-29168P	PE	150	65	15	GPM	IR	groundwater
G3-28424	PE	150	46	10	GPM	IR	groundwater
G3-29099P	PE	3,500	8,676	*	GPM	FP HP IR	groundwater

[1] CE&CC = Certificate, PE = Permit, CL = Claim

* Acreage removed to avoid duplication due to either overlapping water rights or supplemental rights.

Figure 5. Irrigated Acres Impacted by Four Dam Breach on Lower Snake River

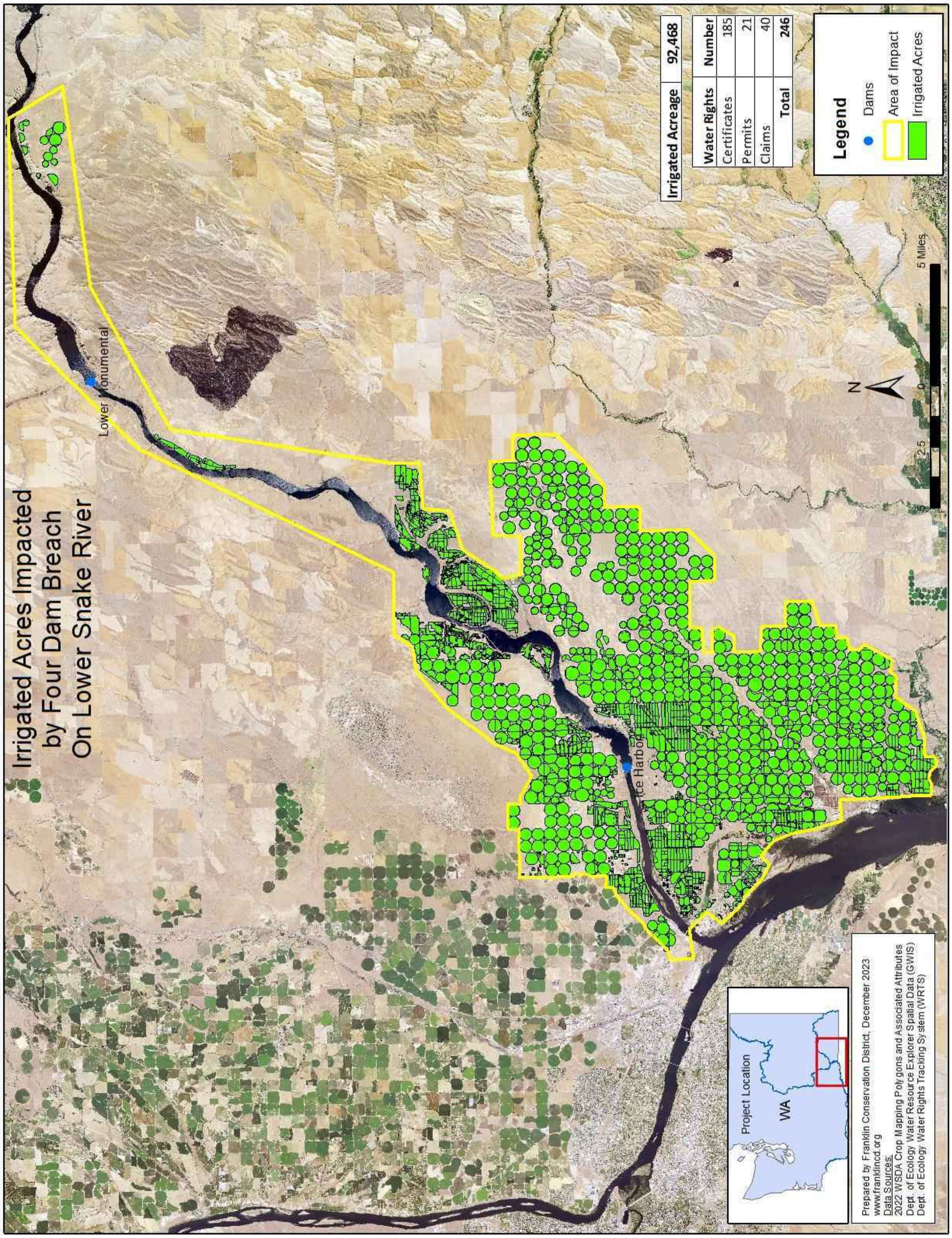


Figure 6. Irrigated Acres Impacted Above Ice Harbor Dam and McNary Pool

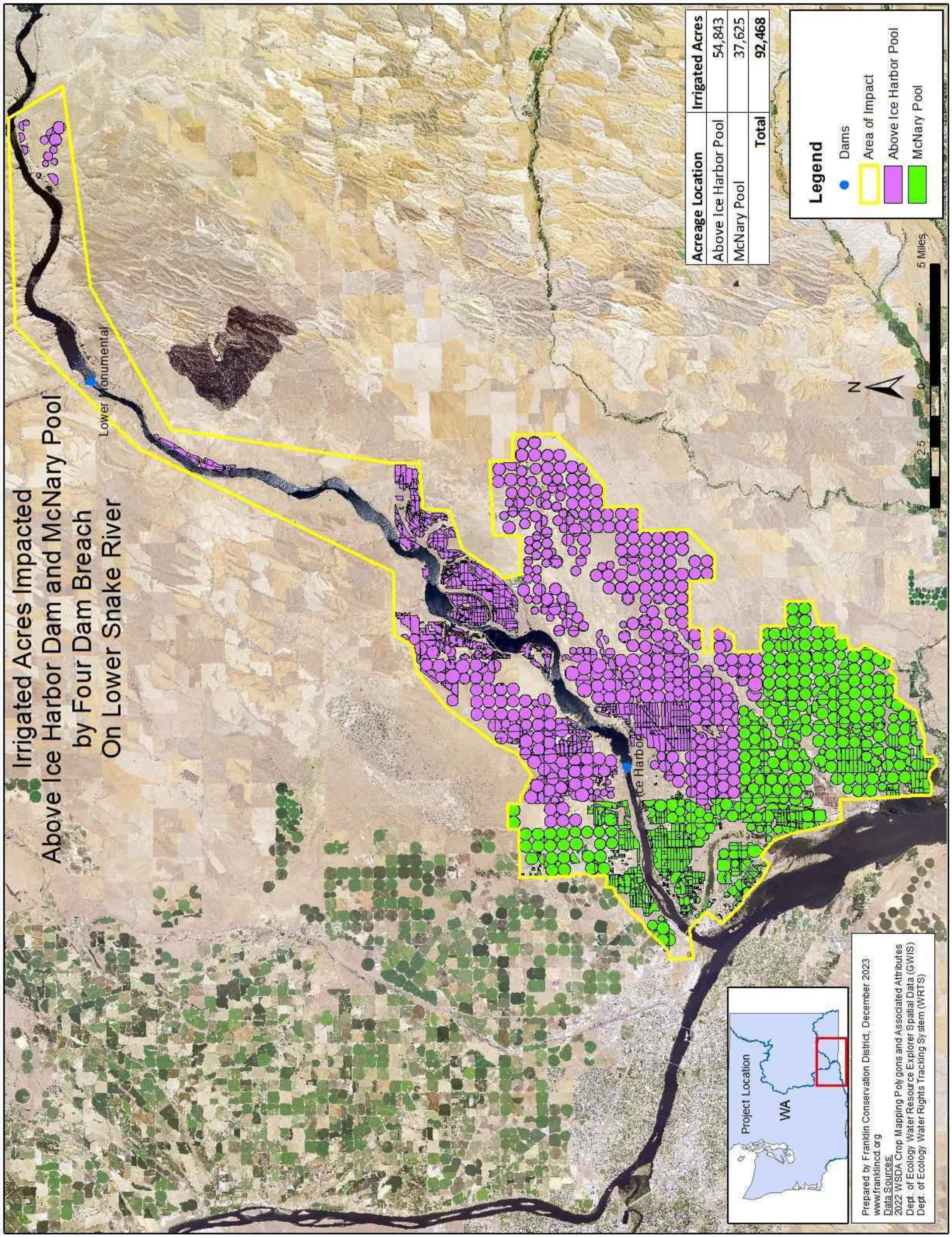


Figure 7. All Points of Diversion/Withdrawal with an Irrigation Use within the Area of Impact

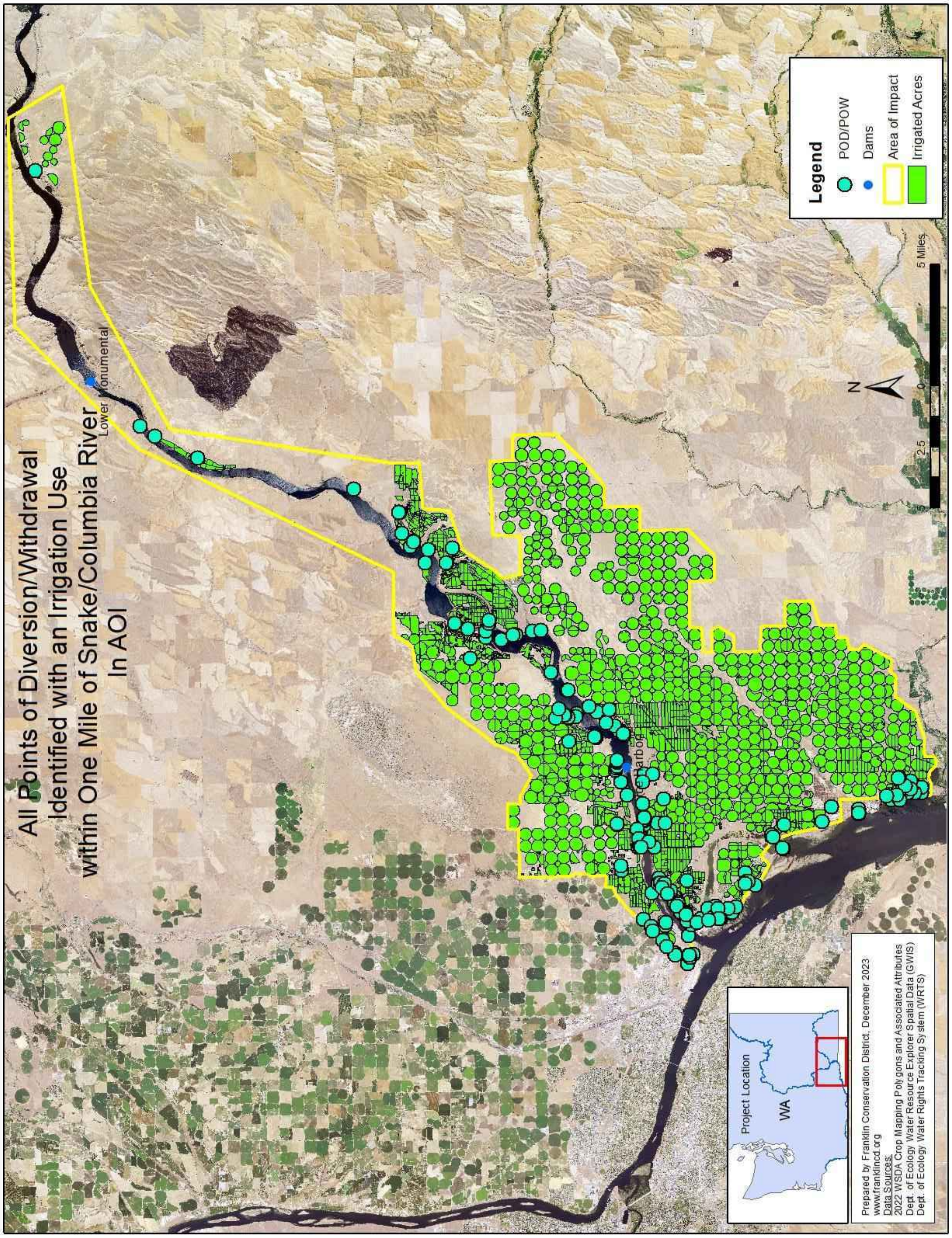


Figure 8. Surface Water Point of Diversion with an Irrigation Use within Area of Impact.

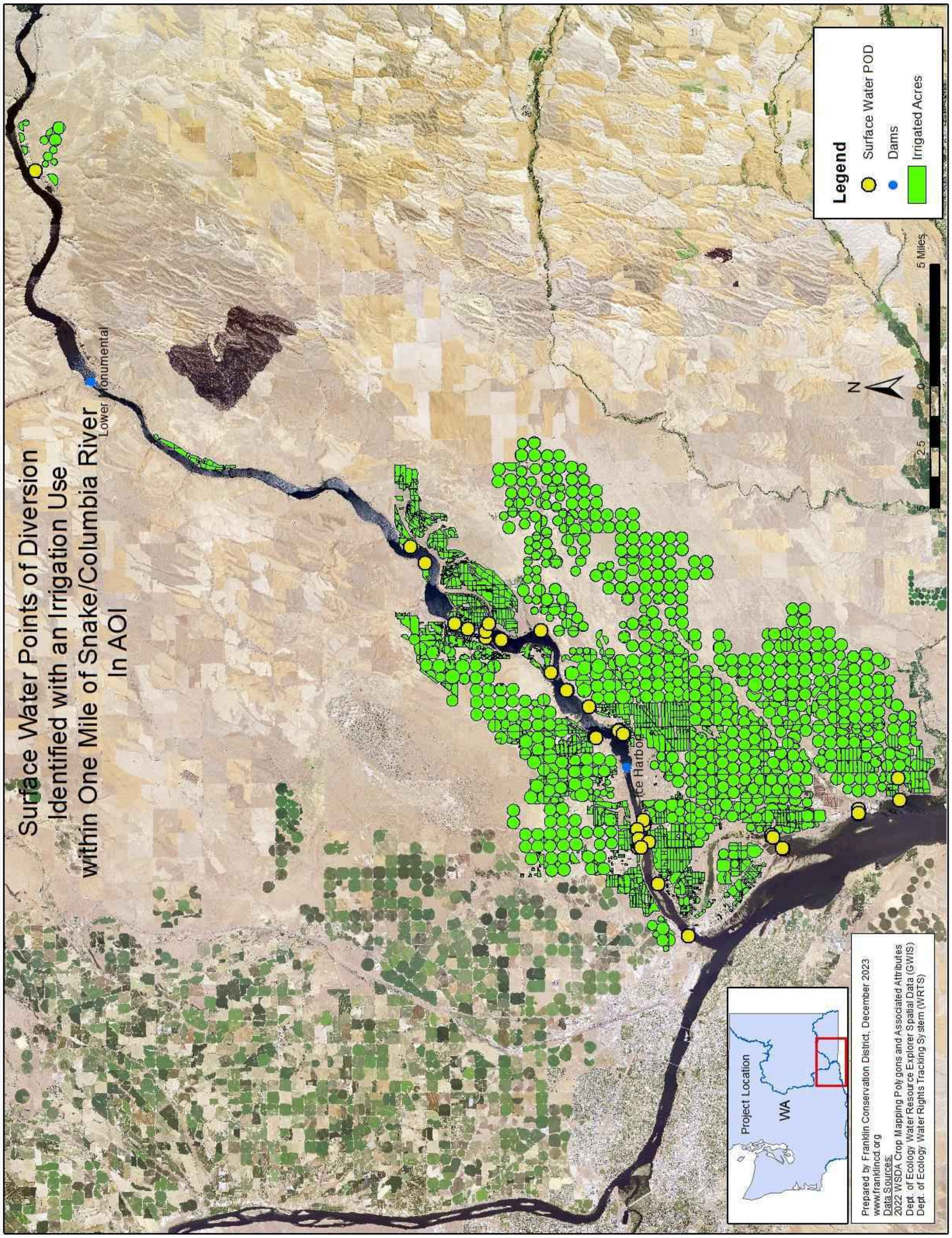


Exhibit 3.
John Day Pool Fish Survival Parameters
And Estimated Juvenile Fish Inriver Survival

Data/Information Source	John Day Pool Configuration	WTT Change	John Day Pool Est. Survival/Change
NOAA-NWFSC CR-2024	Minimum Irrigation Pool	0.0	0.89
	(about 262.5-263.5)	Baseline	Total Survival
Anderson and Hinrichsen 2000	Spillway Crest Drawdown	-2.0	0.90
Technical Memorandum CBR-UW	(about 50ft.)	Days	Total Survival
	Minimum Operating Pool*	-1.0	=<1.0%
	(About 5-6ft., DD to 257.0 ft.)	Days	Change
USACE and NPPC 1994	Minimum Operating Pool*	-0.5	0-2.0%
Cited Estimates (PAM Model no	(About 5-6ft., DD to 257.0 ft.)	Days	Change
longer used, not included here).			

NOTES:
Water Transit Time (WTT).
JDP Reach Distance about 76.4 miles; normal flows at about 250-260 kcfs.
JDP WTT at normal flows about 4.5-5.0 days.
Anderson 2000 indicates about 7.9% survival rate improvement at spillway crest DD (from minimum. irrigation pool, 262-5-263.5).
* Calculated as ratio of John Day Pool spillway crest DD, linear assumption.

SOURCES:

Northwest Fisheries Science Center. 2024. Preliminary Survival Estimates for the Passage of Spring-migrating Juvenile Salmonids Through Snake and Columbia River Dams and Reservoirs 2024. Memorandum, NWFSC, Seattle, WA (November 8, 2024).

Anderson J., Zabel R., and Hinrichsen, R. 2000. Modeling the Impacts of John Day Drawdown on the Survival of Salmonid Stocks. Columbia Basin Research, UW Technical Report, January 2000.

USACE. 1994. Columbia River Salmon Mitigation Analysis System Configuration Study, Phase I, Responding to Northwest Power Planning Council. Walla Walla District, USACE, April 1994; Minimum Operating Pool Technical Report, April 1994.

Northwest Power Planning Council. 1995. Selected Information on John Day Pool Drawdown Options from Various Sources, Portland, OR, August 1995.

And review of Fish Passage Center Draft Annual Report. 2024. CSS Study, Portland, OR. Estimates of Water Transit Time (WTT) Through the River System, Assumptions Regarding Inriver Fish Survival.

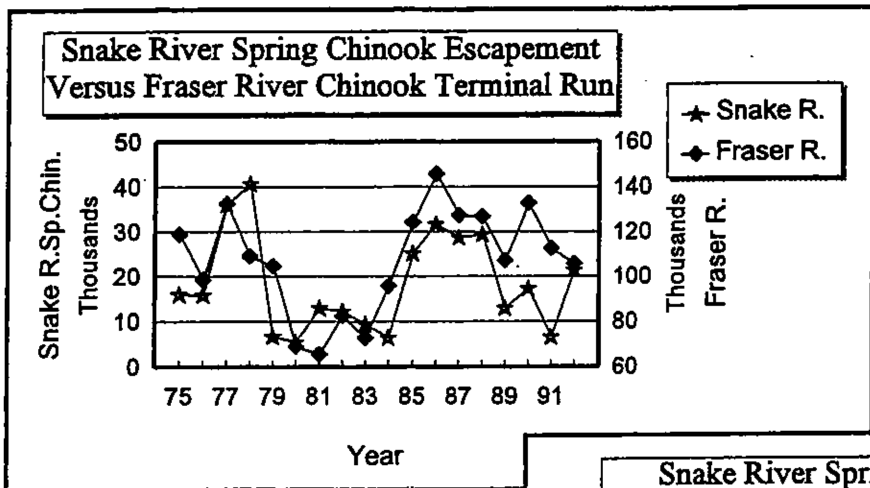
And review of the Columbia River System Operations Final EIS, USACE, USBR, BPA, July 2020, https://www.nwd.usace.army.mil/CRSO/Final-EIS/

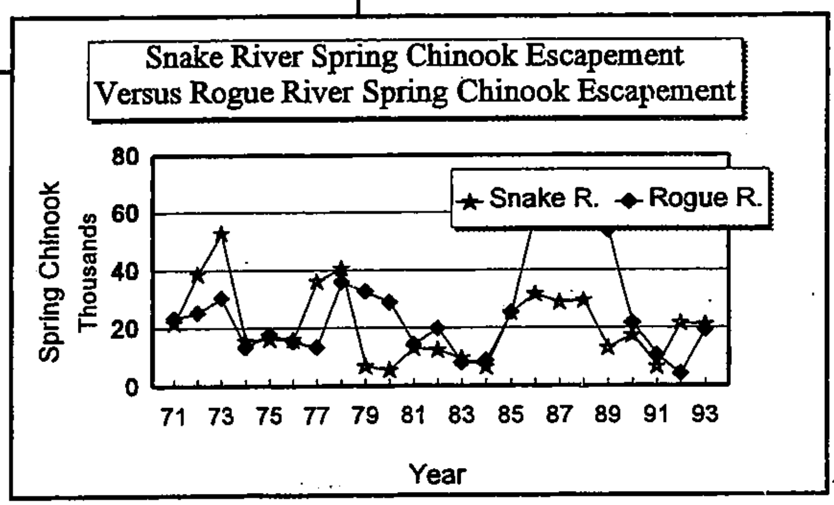
INTER-BASIN COMPARISON STUDY

COLUMBIA RIVER SALMON PRODUCTION

COMPARED TO
OTHER WEST COAST PRODUCTION AREAS

PHASE II ANALYSIS





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October 1994

INTER-BASIN COMPARISON STUDY

COLUMBIA RIVER SALMON PRODUCTION COMPARED TO OTHER WEST COAST PRODUCTION AREAS

PHASE II ANALYSIS

Cycles of ocean productivity can at the very least mask the effects of improvement in freshwater habitat or hatchery production or cause us to falsely attribute increased marine survival to restoration effects in freshwater.

-- J. Lichatowich (1993)
Mobrand Biometrics, Inc.

Environmental factors in the ocean strongly influence salmon abundance in the Pacific Northwest...the cyclical nature of salmon abundance related to fluctuations in the ocean environment will make it difficult to maintain long-term projects in a short-sighted political arena.

-- P. Lawson (1993)
Oregon Dept. of Fish & Wildlife

Any attempts to understand the impact of in-river action on survival will be confounded by changes in ocean conditions. The poor returns of chinook salmon in the early 1990s are to a large extent almost certainly due to poor ocean survival, whether or not they encountered dams.

-- R. Hilborn, et al., (1993)
University of Washington

This study focuses on the research question of whether Snake-Columbia River chinook salmon production trends have been and are currently being affected by changes to ocean ecological and environmental conditions; and if so, what would be a viable approach to assessing the impacts of ocean conditions within further technical analyses. It is prompted by a highly pragmatic objective: the need to better understand and account for factors that can detract from an ability to measure the performance of actions taken within the freshwater river system to recover and enhance weak salmon stocks, particularly the Snake River chinook runs. Among several factors, ocean ecological conditions are recognized as being capable of significantly "overshadowing" the effects of positive measures taken to increase salmon production within the freshwater system (Snake River Salmon Recovery Team 1994).

Gaining an appreciation for the extent that ocean ecological conditions can influence production trends does not limit an obligation by Snake-Columbia River hydroelectric power system operators to take biological and cost-effective actions toward salmon recovery and enhancement. In-river salmon and steelhead protection and enhancement responsibilities are clearly dictated by the Northwest Power Planning Act--within the Columbia River Basin Fish and Wildlife Program--and the recovery planning statutes of the Endangered Species Act.

But a greater understanding of ocean ecological effects on salmon production will allow resource managers to better assess the "success or failure" of freshwater recovery measures. Freshwater salmon recovery actions do not, and will not, function independently from other crucial factors affecting salmon production trends. An assessment and monitoring process for ocean effects will likely require that Snake-Columbia River salmon runs should be gauged against some measure of West Coast salmon production, as well as production trends within other river basins.

The Phase II Analysis presented here represents a continuation of the work initiated within the Phase I Analysis (Richards and Olsen 1993). The Phase I Analysis accomplished three basic tasks:

- It assessed whether adequate data was available to review inter-basin salmon production trends, taking into account technical limitations and areas for additional data collection.

- ➢ It offered empirically based support for *presenting the hypothesis* that ocean ecological or inter-related inland climatic conditions have had a marked impact on Columbia River and other coastal basin salmon production, relative to an overview of chinook salmon production along the West Coast and within individual production basins.

- ➢ It identified additional research needs and objectives for the Phase II and III Analyses.

Within Phase II, additional empirical data are considered, key technical literature and stock assessments are reviewed, and the direction for additional technical work is identified that will aid freshwater recovery planning and assessment.

Phase II Analysis Methodology:

The Phase II analysis follows four basic steps: 1) a review of key data sources and literature relevant to stock assessments, West Coast escapement goals, and ocean ecological effects; 2) a review of estimates of West Coast chinook salmon production and basin production trends over time, with a comparison to Snake River salmon production; 3) a review of the relevant technical comments on the Phase I Analysis/request for Phase II scope-of-work comments; and 4) defining the principal research and policy objectives for further technical work and designing the major scope-of-work tasks for a final Phase III Analysis.

Key Literature Review: A large body of technical data/literature exists that examines stock assessments, escapement goals and objectives, ocean ecology-climatic and biological factors, and salmon and steelhead production trends. For the purposes of this study, the data/literature review primarily concentrates on: 1) descriptions of the extent or range of weak and depressed stocks along the West Coast, including a stock escapement goal assessment; and 2) sources describing the ocean conditions and salmon production relationship. Also, recent work analyzing the relationship between West Coast steelhead production trends and ocean conditions is reviewed in detail. The literature review objectives are to establish whether the broad scientific community either supports or substantiates a hypothesis concerning the effects of an ocean ecological condition-salmon production relationship, and how such a relationship should be recognized when assessing the merits of actions to improve the freshwater environment.

West Coast Salmon Stock Assessments: Several researchers have noted that many salmon stocks along the Pacific West Coast have witnessed dramatic declines during the past few decades. Perhaps the most often cited work that summarizes this widespread decline is the review by Nehlsen, Williams, and Lichatowich (1991) that focuses on native-naturally spawning salmon and steelhead stocks in Washington, Oregon, Idaho, and California. This review concluded that 101 stocks were at high risk of extinction, 58 were at moderate risk of extinction, and 54 were designated as being in a state of "special concern." The review further noted that 39 of the "criteria" stocks occur in California, 58 on the Oregon Coast, 76 within the Columbia River Basin, and 41 along the Washington Coast or within the Puget Sound area. The authors stress that multiple factors are responsible for the declines, and suggest that resource managers should concentrate efforts on restoring freshwater habitat and improving harvest management and hatchery practices.

Other key sources for stock condition information are provided by the Washington State Salmon and Steelhead Stock Inventory (WDF/WDW 1992), the Oregon wild stock assessment prepared by Kaczynski and Palmisano (1992), and the status report (literature review) on anadromous fish of Western Oregon and Northern California prepared by the Center for the Study of the Environment (Botkin, et al. 1993). Within the Washington inventory, state biologists identified 136 stocks that were designated as either in a depressed or critical condition. Fifty-six of these stocks are within the Puget Sound area, 8 are along coastal streams, 35 within the Lower Columbia River (below Bonneville Dam), and 36 within the Upper Columbia River. The Oregon assessment identifies several decreasing (and increasing) stocks along the Oregon Coast, as well as within the Columbia River system. The authors of the Oregon stock assessment primarily review the key factors for stock declines, attempting to assess the effects of past fisheries management practices, hydroelectric power development, forestry and mining impacts to habitat, irrigation impacts, and naturally caused mortality stemming from marine mammal predation and ocean production conditions.

General condition and abundance trends for British Columbia (BC) salmon stocks have been reviewed by Northcote and Atagi (1994). The combined stocks of Pacific salmon for the major BC drainage basins increased from about 10 million fish to 20 million between the 1950s to the mid-1980s. This trend increase has been largely driven by increases to pink and sockeye escapements and production. Chum and chinook salmon have not demonstrated an increasing or decreasing long-term abundance trend (40-year period), while coho have exhibited a significant decreasing abundance trend. The declines in coho abundance are thought to be largely due to over-fishing, freshwater habitat loss, and poor ocean conditions.

Chinook escapements within BC have displayed a variety of trend changes. Within the Fraser River--a major Pacific Salmon production basin--chinook numbers have gradually increased during the past four decades, although Northcote and Atagi (1994) note that increases during the past decade are likely a result of changes to ocean commercial fisheries management practices implemented in the early 1980s, as well as the curtailment of in-river commercial fisheries since the late 1970s (personal communication with Atagi, August 1994). Still Fraser River chinook escapement has greatly oscillated since the mid-1970s. Chinook numbers declined during the late 1970s, moderately increased and declined during the early 1980s, increased dramatically during the mid-1980s, then declined sharply during the late 1980s, with a rebound occurring in more recent years (see Figure 7d.). For the south-central BC coastal drainages, chinook escapements have been declining (trend line) since the mid-1960s but have oscillated during the past fifteen years, now moving upward. The Vancouver Island chinook have followed a downward trend over the 1960-1980 period, but in recent years (since 1987) have displayed a strong upward production trend. The Skeena-Nass systems have displayed escapement trends, since the mid-1970s, somewhat similar to that of the Fraser River.

West Coast Steelhead Stock Assessment: A comprehensive review of steelhead abundance and production trends along the Pacific Coast has been conducted by Cooper and Johnson (1992) with the Washington Department of Wildlife. These researchers have examined trends in winter-run, summer-run, hatchery and wild steelhead abundance in several geographical areas in Washington, and then compared these trends to steelhead abundance in Oregon and British Columbia. Within this assessment, factors not in common with all geographical areas and factors in common with the geographical areas were identified to the extent possible. Particular attention was given to the physical and biological properties existing within the ocean environment, such as climate, currents, sea temperatures, and primary and secondary biological production.

Cooper and Johnson (1992) discussed several basic observations:

- For Washington State steelhead abundance and production, there have been long-term fluctuations and recent declines in winter-run, summer-run, hatchery, and wild steelhead abundance and survival in several different geographical areas. Similarities in survival trends over widespread geographical areas indicate that common factor(s) to each of these areas are responsible for changes in steelhead survival.

- There are similarities in the overall trends and year-to-year trends of winter-run, summer-run, hatchery and wild steelhead abundance in British Columbia, Washington, and Oregon. Again, similarities in survival trends over widespread geographical areas indicate that common factor(s) to each of these areas are responsible for changes in steelhead survival.

- Most wild steelhead runs in Washington reached established escapement goals during 1984-85 through 1986-87, the brood years which would have contributed to the decline of steelhead abundance since 1989. Low spawner escapement would, therefore, not explain the decline in steelhead abundance in recent years.

- Harvest of steelhead in high seas driftnet fisheries may have contributed to the decline in steelhead along the Pacific Coast. Authorized and unauthorized fisheries combined may have harvested between 5% and 31% of the steelhead along the Pacific Coast.

- Freshwater, estuarine and near shore rearing conditions are substantially different between geographical areas along the Pacific Coast and hydroelectric dams and incidental catch of steelhead in commercial fisheries do not occur in all areas. While these factors can be very important in determining survival of regional or individual populations, they would not readily explain the similarities in steelhead survival trends along the Pacific Coast.

Given their review, Cooper and Johnson (1992) concluded that:

> Similarities in overall trends and year-to-year trends of steelhead abundance in widely separated geographical areas strongly indicate that common factors are responsible for the recent decline in steelhead abundance along the Pacific Coast. If substantial or consistent differences in survival trends in different geographical areas were present, this may have indicated differences were present in regional or individual freshwater, estuarine, or near shore areas. Similarities in survival trends, however, strongly indicate that oceanic conditions are primarily responsible.

West Coast Chinook Salmon Escapement Goals: A summary table and detailed data for several West Coast chinook salmon escapement goals, for various river basins, are included within Appendix A. Spawning escapement goals are set by resource management agencies to achieve sustainable production levels over time. Achieving an escapement goal is dependent on: an ability to limit harvest on selected stocks within mixed-stock fisheries over broad geographical areas; the quality of available habitat; and environmental conditions within the ocean environment.

Much of these data are developed by the Joint Chinook Technical Committee (CTC) that was created as part of the Pacific Salmon Treaty. The CTC has examined spawning escapement data and related information as part of a long-term (15-year) rebuilding program for 42 natural spawning chinook indicator stocks from Central Oregon to Southeastern Alaska. Many of these escapement goal stocks are the same stocks evaluated within the inter-basin comparison section within this study.

Table A1. (Appendix A) summarizes the escapement goal performance records for several West Coast river basins, with individual basin year-to-year data trends depicted in the following appendix tables. These data indicate that several West Coast river basins achieved relatively high percentages of their escapement goals during the latter 1980s (1985-1989 period), with low escapement goal percentage occurring during the early 1980s and early 1990s. For wild and hatchery fish, this escapement goal pattern generally prevailed within the California Central Valley basins, the Klamath River, the Rogue River, the Snake and Columbia rivers, the Washington Coastal river runs, the Puget Sound area, the Fraser River system, and for some of the Northern BC and Southeast Alaska runs.

Also, some runs have achieved escapement goal objectives more often than others. For example, from the CTC index stocks, the California Central Valley and Washington Coastal runs have met escapement goals a high percentage of the time, whereas several Upper Columbia River stocks have seldom met escapement goals during the past fifteen years. The remaining index stocks have displayed mixed and inconsistent results in meeting escapement goals. In recent years, the CTC notes that: "18 of the 42 indicator stocks had lower escapements in 1992 than in 1991 and less than half (15 of 36) of the escapement indicator stocks with goals are currently classified as above goal, rebuilding, or probably rebuilding. This is especially significant since most stocks are now more than halfway, and the remainder more than two-thirds through their rebuilding programs" (Pacific Salmon Commission 1993).

Ocean Climatic/Ecological Conditions and Salmon Production: There exists a substantial amount of technical literature analyzing ocean climatic/ecological conditions relative to biological productivity. It is reasonably well understood that climatic changes can affect physical, biological, and chemical processes within the marine environment that either directly or indirectly impact fish populations and production trends. Ocean current speed and direction, temperature, salinity, and strength of upwelling all affect primary and secondary biological productivity (Hobson 1980; Tabata 1984; Nickelson 1986; Landry and Hickey 1989; Bakun 1990; Ware and Thomson 1991), and inter-related North Pacific salmon production trends (Pearcy 1984, 1992; Beamish and Boulin 1993).

In particular, prevailing winds drive surface waters offshore from the Pacific Coast (Southern Canada, US, and Mexico), causing deeper, nutrient transporting water to "upwell" to the surface. This nutrient-rich water stimulates plankton growth that in turn supports a foodchain vital to Pacific salmon. Periods of high or increased upwelling are important to salmon production (Bakun, et al. 1983; Beamish and Bouillon 1993; Pearcy 1994; Northwest Power Planning Council 1994).

Within the North Pacific, major ocean currents define broad production areas. There exists a north flowing Alaska Current (flowing from North Vancouver Island area to the Southeast Alaska) and a south flowing California Current (flowing from South Vancouver Island area to along the Mexican North Coast), which are separated by a Subarctic Current and transition zone (North-Central British Columbia). Pearcy (1992) indicates that periods of high sea temperatures along the Pacific Coast and an intense Aleutian low in the Northeastern Pacific since 1977 have had positive effects in the Gulf of Alaska region but negative effects in the California Current area--the two currents operating "out-of-phase" relative to ocean productivity.

Episodic "El Nino events" within the California Current--roughly occurring between 1982-83 and the early 1990s--have suppressed primary and secondary ocean production and dramatically affected North Pacific salmon production (Bakun 1983; Nickelson 1983; Johnson 1984; Huyer and Smith 1985; and Pearcy 1992, 1994; Northwest Power Planning Council 1994). During an El Nino event, wind and wave patterns change, bringing warm surface waters and easterly winds to the Pacific Coast. Normal upwelling trends are suppressed, with resultant changes to nutrient transport and ocean productivity. For example, during the 82-83 El Nino event, zooplankton abundance was reduced to 30% of the level existing in non-El Nino affected years. Salmon production suffered significantly, with extremely low smolt, jack, and adult coho salmon numbers recorded.

Ocean Conditions and Freshwater Management: Some researchers also have addressed the issue of how ocean environmental conditions can influence freshwater management actions, or the perceived influence of such actions. Lichatowich (1993) stresses that "cycles of ocean productivity can at the very least mask the effects of improvement in freshwater habitat or hatchery production or cause us to falsely attribute increased marine survival to restoration effects in freshwater." This view is shared by the Snake River Salmon Recovery Team (1993), where they assert that "oceanic conditions may often override freshwater factors in determining trends and status of salmon populations." This point is further reinforced by Hilborn, et al., (1993) within their review of flow-juvenile salmon survival relationships within the Columbia River: "Any attempts to understand the impact of in-river action on survival will be confounded by changes in ocean conditions. The poor returns of chinook salmon in the early 1990s are to a large extent almost certainty due to poor ocean survival, whether or not they encountered dams." Given the importance of ocean ecology, both Lichatowich (1993) and Lawson (1993) maintain that fluctuating ocean conditions require resource managers to place an even higher priority on improvements to freshwater habitat and environment. It becomes critically important to put into place freshwater recovery measures that can "withstand" or "offset," to the extent possible, periods or poor ocean conditions and salmon production.

Coastal/Inter-Basin Chinook Salmon Production Comparison:

For the Columbia River system, the inter-basin comparisons reviewed within the following material primarily focus on the Snake-Columbia spring chinook run, as counted at Lower Granite Dam (Snake River spring chinook escapement). The Snake River spring chinook provide a good indicator run or "yardstick" for measurement, because the run is subjected to limited ocean or in-river harvest, but it does incur down-river and up-river migration passage effects caused by eight major hydroelectric power dams. Consequently, similar production or abundance (harvest and escapement) trends between the Snake River spring chinook and other areas would indicate the presence of a strong coast-wide production influence, presumably caused by either ocean environmental conditions or inter-related inland climatic effects. Columbia-Snake River fall chinook are evaluated as well, but to a lesser extent than the spring chinook.

The inter-basin comparison review also adopts two basic perspectives. The first perspective is to compare the Snake River spring chinook run to broad aggregations of West Coast chinook production. The strength of this perspective rests on the dominance of consistency in production trends despite the fact that many different variables affecting production--such as harvest and hatchery management practices, abundance of wild stocks, smolt production, and freshwater impacts--exist along the coast and among different production basins. It would not be expected to observe much consistency among the production or run size trends, unless there did exist some common factor(s) affecting the different runs. The obvious factor(s) is the ocean environment and/or its inter-relationship with inland climate.

The second perspective is to compare the Snake River spring chinook run to runs within other major chinook production basins along the West Coast. Here again, similar production trends would suggest the presence of dominant or common factors affecting the run sizes.

Changes to production trends, and basin trend similarities, can be described as measures of linear path (linear trends, generally increasing or decreasing), measures of statistical correlation (correlation coefficient), and patterns of similar trend oscillations or increasing-decreasing scale over time. The latter measure--similar oscillatory or increasing-decreasing trend patterns--would likely be the most visible and apparent feature if dominant or common factors were affecting the runs over short to mid-term time scales.

The aggregated West Coast production areas and specific production basins are outlined within the Inter-Basin Review Table, which includes a salmon stock identification summary.

Aggregated Coastal Systems/Areas Comparison: A comparison of aggregated coastal systems/areas to Snake River spring chinook production is provided by Figures 1a-b. and 2a-d., and Tables 1. and 2. The aggregations form three different approaches. The first approach, illustrated by Figures 1a-b., relies on a production index method, where total ocean commercial and sport harvest serves as the measurement index (U.S., Canada, Southeast Alaska chinook salmon catches). The second comparison approach is based on an estimated total West Coast aggregation method (all ocean-river harvest and run escapements, see production areas in Table 2.), as illustrated by Figures 2a-b. Ocean harvest (production index) versus the estimated total West Coast production trends are compared in Figure 2c., suggesting that the production index mirrors total production trends. And the third comparison approach is depicted by Figure 2d. portraying an estimated U.S. ocean harvest and river run aggregation.

When compared to the Snake River spring chinook run, the aggregated systems/areas display some similarities. Compared to the production index and West Coast production aggregations, a general downward decline exists during the late 1970s, with a sharp decline apparent for the Snake River spring chinook run (1978-1979). During the early 1980s, a modest production increase occurs, followed by another decline, with a sharp production increase taking place during the 1986-1988 period; thereafter, production trends move rapidly downward during the late 1980s-early 1990s time frame, though some initial "rebound" is indicated by the Snake River run. Both the production index and estimated West Coast total aggregation approaches display similar general linear trends to that of the Snake River spring chinook, with the

INTER-BASIN REVIEW TABLE

Stock Data	Location	Types of Chinook Stock
West Coast	West Coast (Pacific West Coast)	Production Index (Ocean Harvest) Estimated Aggregated Production Ocean and In-River (All Chinook)
U.S.	U.S. Coast Ocean/In-River	Ocean Harvest/In-River Production (All Chinook)
PFMC	Pacific Coast (Incl. Canada and S.E. Alaska)	Ocean Troll and Recreation (All Chinook)
Canada	British Columbia	Ocean Troll and Recreation (All Chinook)
North/Central Coast	British Columbia	(All Chinook)
Canada/W. Vanc. Island	British Columbia	(All Chinook)
St. of Georgia/Fraser	British Columbia	(All Chinook)
Johnstone St.	British Columbia	(All Chinook)
Juan de Fuca St.	British Columbia	(All Chinook)
Fraser River	British Columbia	Spring/Summer (Terminal Run) Wild Chinook
Southern B.C.		(Wild Chinook)
West Coast Vanc. Isl.	S.W. British Columbia	Escapement
Lower Georgia St.	S.W. British Columbia	Total Run
Upper Georgia St.	S.W. British Columbia	Escapement
Northern B.C.		(Wild Chinook)
Nass	North/Central Br. Columbia	Total Run
Skeena	North/Central Br. Columbia	Total Run
Yakoun	North/Central Br. Columbia	Escapement
Southeast Alaska	Southeast Alaska	Ocean Troll and Recreation (All Chinook)
Washington/Oregon		
Snake River	S.E. Washington/Idaho	Spring/Summer (Hatchery and Wild) Fall (Wild Run)
Columbia River	Oregon/Washington	Spring/Summer and Fall
Lower Columbia	N.W. Oregon and S.W. Washington	Spring (In-River Run) (Hatchery and Wild)
Upper Columbia	S.E. Washington	Spring (In-River-Run) (Escp.) (Hatchery and Wild) Summer Escapement
Bonneville Dam	Lower Columbia River	Spring (Hatchery and Wild) Summer Escapement
Priest Rapids Dam	Upper Columbia River	Spring (Hatchery and Wild) Fall (Hatchery and Wild) Spring (Hatchery and Wild)
Upper River Dams	Upper Columbia and Snake	Fall (Hatchery and Wild) Spring (Hatchery and Wild)

INTER-BASIN REVIEW TABLE

Upper River	Upper Columbia River	Spring (Hatchery and Wild)
Lower River	Lower Columbia River	Spring (Hatchery and Wild)
McNary Dam	S. Central Washington	Fall (Hatchery and Wild)
Ice Harbor Dam	S.E. Washington	Fall (Hatchery and Wild)
Above Lower Granite	S.E. Washington	Hatchery Escapement
Washington Coastal Rivers	Washington Coast Rivers	Spring/Summer (Terminal Runs)
Cowlitz River	S.W. Washington	Spring (Hatchery and Wild)
Lewis River	S.W. Washington	Spring (Hatchery and Wild)
Kalama River	S.W. Washington	Spring (Hatchery and Wild)
Willapa Bay	South Washington Coast	Fall (Hatchery and Wild)
Grays Harbor	Central Washington Coast	Spring; Spring/Summer; and Fall (Hatchery and Wild)
Queets River	North Washington Coast	Spring/Summer and Fall (Hatchery and Wild)
Hoh River	North Washington Coast	Spring/Summer and Fall (Hatchery and Wild)
Quillayute River	North Washington Coast	Spring/Summer and Fall (Hatchery and Wild)
Puget Sound	N.W. Washington	Spring/Summer/Fall (Production) Summer/Fall (Com./Marine Harvest & Escp)
Str. of Juan de Fuca	N.W. Washington	Summer/Fall (Hatchery & Wild)
Nooksack/Samish	North Puget Sound	Summer/Fall (Hatchery & Wild)
Skagit	Central Puget Sound	Summer/Fall (Hatchery & Wild)
Hood Canal	Hood Canal	Summer/Fall (Hatchery & Wild)
Stillaguamish-Snohomish	Central Puget Sound	Summer/Fall (Hatchery & Wild)
So. Puget Sound	South Puget Sound	Summer/Fall (Hatchery & Wild)
Oregon Coastal	Oregon Coastal Rivers	Spring/Fall (Hatch. Escp. & Freshwater Hvst)
Klamath River	S. Central Oregon and N. California	Fall (In-River Run) Fall (Spawning Escp.) (Hatchery and Wild)
Rogue River	S.W. Oregon	Spring/Fall
Above Gold Ray Dam	S.W. Oregon/Rogue River	Spring (Hatchery and Wild)
Sandy River	N.W. Oregon	Spring (Hatchery and Wild)
Willamette River	N.W. Oregon	Spring (Hatchery and Wild)
California	California Central Valley	
California Central Valley	California Central Valley	Spring/Fall Fall and Other (Hatchery & Wild) Abundance Index (Harvest-Escp.) Ocean Harvest and Escapement
Sacramento River	N. California Central Valley	Fall Escapement (Hatchery and Wild)

INTER-BASIN REVIEW TABLE

estimated West Coast production indicating a moderate level of correlation (r = .56) relative to the Snake River run.

Figure 2d. compares the estimated U.S. ocean harvest-river run size aggregation (including Puget Sound) to the Snake River spring chinook run for the 1981-1992 period (period of most complete data). The oscillatory pattern similarity is apparent, with a moderate to high level of correlation (r = .70).

Inter-Basin Comparisons: The Lower and Upper Columbia River in-river chinook runs are compared to the Snake River spring chinook run in Figures 3a-d. and Tables 3a-b. A similar oscillatory trend exists for both the Upper and Lower Columbia River spring chinook runs relative to the Snake River run, though the Lower Columbia run appears to moderately lag behind the Snake River run trend since the mid-1980s. Statistical correlation between the Lower Columbia and Snake River spring chinook runs is weak (r = .14), whereas a much higher correlation exists between the Upper Columbia-Snake runs (r = .90).

Figures 3c-d. provide a comparison of the combined Cowlitz, Lewis, Kalama, and Sandy River spring chinook runs, and the Willamette River runs, to that of the Snake River spring chinook run. Here, some similarity among oscillatory patterns or short-term, increasing and decreasing production trends can be detected, but statistical correlations between the trends are weak.

In Figure 3e., spring chinook escapement at Priest Rapids Dam on the Mid-Columbia is compared to the Snake River spring chinook run. The oscillatory trend pattern of the two runs is quite similar and correlation is moderate to high (r = .71). It is noted that both runs appear to be making an initial "rebound" from the late 1980s-early 1990s declines. From a linear trend perspective, the Mid-Columbia run is moving upward, based on the 1975-1993 period.

Figures 4a-b. and Table 4. illustrate the trend comparison relative to the California Central Valley abundance index (ocean harvest and in-river runs) and the Snake River spring chinook run. A similar oscillatory pattern emerges between the two runs, beginning in the late 1970s. Linear trend patterns are relatively the same, with a low to moderate correlation level (r = .37).

The Sacramento and Klamath River spring/fall chinook runs are compared to the Upper Columbia-Snake River runs in Figures 5a-b. and Tables 5a-b. The high "peaking period" during the mid-to-late 1980s, followed by a rapid decline, is readily observable among the runs (note that Table 5b. provides a disaggregation between hatchery and wild fish for the Sacramento and Klamath River runs). Correlation levels between the Sacramento and Klamath Rivers and Columbia-Snake River fall chinook runs are moderate to high (r = .52 and .81, respectively).

Rogue River spring chinook escapement above Gold Ray Dam (Upper Rogue River) is compared to the Snake River spring chinook run in Figures 6a-b. and Table 6a. The oscillatory pattern between the two escapement runs is relatively similar, and the correlation level is within a low to moderate range (r = .35). Figure 6b. provides a comparison of the Rogue hatchery versus wild escapement at Gold Ray Dam. Additional trend comparisons for Oregon coastal hatchery escapement versus freshwater harvest, for spring/fall chinook, are provided in Figures 6c-d. and Table 6b.

Figures 7a-b. and Table 7a. present the trend relationship between Washington Coastal chinook runs and the Columbia-Snake River chinook runs. In Figure 7a., the combined Washington

Coastal spring/summer chinook river runs (Grays Harbor, Hoh, Quillayute, and Queets rivers) are contrasted to the Snake River spring chinook run. A similar oscillatory trend is noticeable, and the correlation level is within a moderate to high range (r = .67). Also, the relationship between the Quillayute River fall chinook run and the Upper Columbia-Snake fall chinook run is depicted within Figure 7c. Here, the similar oscillatory trend is noted, with both runs indicating a relatively high correlation level (r = .81).

Figures 7c-d. and Table 7b. display the relationship between the Puget Sound (aggregated basin runs) and Fraser River chinook runs, and the Snake River spring chinook run. Similarities between the Puget Sound Region (commercial/marine harvest and multiple basin escapement), and the Snake River run are less apparent. The most observable mutual trend is the late 1980s-early 1990s decline; the overall correlation during the 1981-1992 period is very weak (r = <.1). In contrast, the trend relationship displayed in Figure 7d. between the Fraser River run and the Snake River run is highly consistent, and holds moderate correlation (r = .64).

Within Figure 8. and Table 8., the Snake River spring chinook run is disaggregated between hatchery versus wild returns over Lower Granite Dam. During the 1980s period, both hatchery and wild runs have followed similar increasing and deceasing trends, though the wild salmon numbers have been generally less than the hatchery fish.

Coastal and Inter-Basin Comparison General Summary: Similar production trends can be observed between West Coast aggregated chinook production and the Snake River spring chinook run; this holds true for both a production index measure based on ocean harvest and for an estimated total aggregate production measure, including ocean-river harvest and river escapement for chinook. This trend comparison reflects similar oscillatory trends--short-term increasing and decreasing trends--since the late 1970s. In general, similar run size trends can be observed between several West Coast river basins and the Snake River spring chinook run; the same effect can be noted for some fall chinook runs. Also, moderate level statistical correlations between the runs, while not convincing in-and-of themselves, lend further notice to the presence of similar production trends.

Based on the review of the trends noted above (figures and tables cited) as well as from a review of additional run size data contained within the primary references (see table citations), it appears that ocean and in-river harvest levels have been generally proportional to river run escapements over time; that is, neither ocean nor in-river harvest levels show increasing trends during periods of declining river escapement (though some exceptions may exist). Consequently, it would be inappropriate to conclude that harvest levels are primarily responsible for the major thrusts of the oscillatory trends exhibited by West Coast or basin production--other factors are likely responsible. Harvest would likely have more of an effect on long-term, linear production trends.

Coupled with the above discussion on stock status and ocean environmental conditions affecting West Coast salmon (and steelhead) production, the empirical data presented here depicting similar trends among the coastal and inter-basin production areas would strongly support the hypothesis that ocean ecological or inter-related inland climate conditions have had a marked impact on Columbia River and other coastal basin salmon production. In general, the fluctuating coastal and inter-basin production trends coincide with periods of observed poor ocean conditions or El Nino events, such as during the early 1980s and 1990s. If this hypothesis--or basic observation--is accepted, then effort should be put forth to better measure the magnitude of ocean condition effects on freshwater production levels for the Snake River chinook stocks.

Review of Comments on Phase I Analysis and Phase III Scope-of-Work Recommendations: Comments on the Phase I Analysis and recommendations for further study have been solicited in two phases. With the completion of the Phase I Analysis, the Corps distributed copies and requests for comments to state and federal resource agencies, managers, and scientists; university researchers; industry researchers and consultants; and other interested parties. Over one hundred individuals, agencies, and organizations were contacted.

A second phase of solicitation for comments and further study design recommendations was conducted as part of the work for the Phase II Analysis. This included requests from agencies and individual researchers previously contacted who had not responded to the first request, as well as new reviewers. Over fifty individuals, agencies, and organizations were contacted. The emphasis of this request was to identify tasks for a more detailed study design and to receive information about new or available data sources.

From the two requests for comments, written and verbal responses were received from: The Direct Service Industries, Inc.; Gary Morishima (MORI-ko Consulting); Harza Pacific Northwest; the Fish and Wildlife Committee of the Pacific Northwest Utilities Conference Committee; fisheries biologists from the Bonneville Power Administration; The Northwest Fisheries Science Center, National Marine Fisheries Service; the Sierra Club; researchers with the School of Fisheries, University of Washington; and the U.S. Fish and Wildlife Service.

The key technical comments received from these agencies and individuals are summarized below by conceptual areas. These comments have been adopted either within the Phase II Analysis or are considered or directly adopted within the Phase III Analysis research design. A response to each comment is provided in italics (within brackets).

In-River Production Variables:

- The outmigration production for Snake River spring chinook salmon, as well as for other basins being reviewed should be considered in assessing subsequent adult returns. (*Comment is adopted within the Phase III research design.*)

- Hatchery production within the different sub-basins should be directly considered when comparing adult returns among inter-basins. (*Hatchery versus wild fish production is noted for some basins within the Phase II Analysis, and the comment is adopted within the Phase III research design.*)

- To the extent possible, hatchery versus wild stocks should be separated within the inter-basin comparisons. (*See response to above comment.*)

- It would be useful to assess escapement goals, and whether they are being reached, among the inter-basins as part of the overall assessment of the basin production trends. (*Comment is adopted within the Phase II Analysis, see Appendix A.*)

- Attempt to develop inter-basin comparisons based on brood or juvenile migration year, perhaps using smolt to adult ratios; or consider some form of production ratio between separate basins and aggregated data. (*Comment is adopted within the Phase III Analysis research design.*)

Ocean Environmental Effects:

- The analysis should describe, from the technical literature, how potential ocean environmental conditions can affect salmon populations and production. (*Comment is adopted within the Phase II Analysis.*)

- The analysis should describe, from the literature, how other fish populations have been affected by potential ocean environmental factors. For example, how have West Coast steelhead runs been affected by ocean environmental factors. (*Comment is adopted within the Phase II Analysis.*)

- The study should address the question of how different age classes are affected within the ocean environment. (*Comment is adopted within the Phase III Analysis research design for analyzing different brood years.*)

- For fall chinook, ocean and in-river harvest impacts should be taken into consideration when estimating Snake-Columbia River. (*Comment is adopted within the Phase III Analysis research design.*)

- Ocean harvest has significantly affected terminal run sizes for some basins, and this factor should be taken into consideration when making inter-basin comparisons over time. (*Comment is reviewed and adopted within both the Phase II Analysis and the Phase III Analysis research design.*)

General Methodology:

- Specific research hypotheses should be constructed for testing, for an in-depth inter-basin comparison study. (*Comment is acknowledged both within the Phase I and Phase II Analyses. Hypotheses are acknowledged/stated in general terms for this research, noting that empirical data support the hypothesis that similar inter-basin chinook production trends do exist. Specific hypotheses for specific basin production relationships are not made but will be considered within the Phase III Analysis.*)

- Specific statistical analysis procedures should be identified and employed for an in-depth inter-basin comparison study. (*Some statistical measures are included within the Phase II Analysis, and statistical analysis procedures are directly adopted within the Phase III research design.*)

- More emphasis should be placed on the selection of specific stocks for a comparison between Snake River production and other production basins, as opposed to aggregation. A focus on Lower Columbia River and similar stocks from other basins would be appropriate. (*Comment adopted within the Phase II Analysis and the Phase III Analysis research design.*)

- More emphasis should be placed on a comparison between the Snake River and Fraser River chinook stocks. (*Comment adopted within the Phase II Analysis and the Phase III Analysis research design.*)

- It would be more appropriate to compare in-river run sizes for inter-basin comparisons, as opposed to escapement levels. This adjusts for in-river harvest and in-river losses. (*Comment adopted within the Phase II Analysis and the Phase III Analysis research design.*)

- Data for wild fall chinook from within the Hanford Reach should be included within further analyses. (*Comment adopted within the Phase III Analysis research design, note need to include code-wire tag data evaluation.*)

In addition to the technical comments offered, some reviewers readily acknowledged that ocean conditions have likely affected West Coast salmon production among the inter-basins--particularly during El Nino and post-El Nino events--but expressed great concern that the Phase I Analysis did not adequately recognize or address the detrimental effects of the Snake-Columbia River hydroelectric projects on up-river salmon production. Some reviewers expressed concern that Corps studies should focus exclusively on improving salmon production within the freshwater environment, or that identifying ocean environmental impacts common to the inter-basins served little value in attempting to restore or enhance Snake-Columbia River salmon stocks.

Recommendations for Phase III Analysis, Scope-of-Work:

Recommendations for a Phase III Analysis are based on: 1) a review of the key literature on ocean condition effects discussed above; 2) a review of West Coast and inter-basin production trends for chinook salmon; and 3) the technical comments received on the Phase I Analysis and the Phase II Analysis request for scope-of-work comments.

Given this material and review consideration, it is recommended that the fundamental direction of the Phase III Analysis should be directed toward the development of a metric approach or statistical model to estimate Snake-Columbia River salmon production changes caused within the freshwater environment, separate from production changes caused primarily by ocean conditions. This type of analysis will be required in order to make any meaningful determination regarding the effectiveness of freshwater measures for salmon mitigation and recovery, and developing the capability to make such determinations should be the primary objective of the Phase III Analysis. This is not to suggest that several confounding biological factors relative to freshwater production estimates do not exist and must be recognized, but it does suggest that it is imperative to make a fundamental disaggregation between freshwater and ocean production effects.

The following steps and tasks should serve as the basis for the Phase III study design and scope-of-work.

Primary Research Objective: The primary research objective for the Phase III Analysis is stated below:

- The technical literature and empirical data reviews indicate that ocean environmental conditions can have both short-term and long-term affects on West Coast salmon and steelhead production trends. Given this factor, or support for this hypothesis, a methodology should be developed to estimate the relative effects of ocean environmental conditions from the effects of freshwater conditions for the Snake-Columbia River chinook salmon. This differentiation of impacts will allow resource managers to better measure the effectiveness of measures taken within the freshwater environment to improve the salmon runs.

Principal Research Tasks: The principal research tasks require the selection of Inter-Basin Index Areas, the collection of selected variables for statistical analysis/model review, and the development of adequate and pragmatic statistical procedures to incorporate the selected variables for model review, to assess the effects of the ocean conditions on Snake River spring chinook salmon production levels over time.

Select Inter-Basin Index Areas:

- Inter-Basin Index Areas should be identified and selected to serve as comparison group or "control" productions areas or basins relative to Snake River spring chinook production. The Index Areas may include coastal production aggregations and separate production basins. Several of the production areas/basins reviewed within the Phase II Analysis would be candidate areas for the Index Areas.

- Existing data on the ocean migratory paths for the selected Inter-Basin Index Areas should be reviewed; Index Areas should have consistent or semi-overlapping ocean migration paths to that of the Snake River spring chinook. This should be accomplished through a review of available CWT data, as well as other data sources.

- General information on Pacific Ocean conditions should be reviewed to determine periods of high and low ocean productivity, and likely effects on West Coast salmon survival and production.

Identify Inter-Basin Index Area Carry Capacity Limitations/Constraints:

- Inter-Basin Index Areas' salmon production and escapement could be affected by limiting carrying capacity factors within the production basin habitats. Factors that could limit increased production, at the present time, due to habitat carrying capacity should be identified and quantified to the extent possible, using available data and information sources. Dummy variable designations may be used to quantify existing habitat carrying capacity, for with or without current production size limitations.

Identify Inter-Basin Index Area Variables for Statistical Model Analyses:

- For each Index Area, time series data for ocean and within basin harvest should be collected for use within modeling analyses.

- For each Index Area, time series data for hatchery and wild fish harvest and spawning escapement should be collected for use within modeling analyses.

- For each Index Area, time series data for outmigration production (smolt/juvenile salmon production) should be collected for use within modeling analyses.

- For each Index Area, smolt to adult ratios should be estimated, if adequate data is available, for use within modeling analyses.

- For each Index Basin, time series ratios should be developed for basin total production relative to an aggregated index areas (such as estimated US harvest/escapement production).

- Other relevant quantitative measures of Index Area production should be reviewed for potential inclusion within modeling analyses.

Development of Metric/Statistical Model Approach:

- Existing modeling approaches to assess or control for ocean effects should be identified and reviewed. For example, Hilborn, et al., (1993) have developed a modeling approach to control or account for ocean environmental effects in assessing flow-survival relationships for Mid-Columbia fall chinook, relative to lower river stocks.

- Production models should be developed for the Index Areas and the Snake River spring chinook runs.

- Statistical analysis techniques should be reviewed and adopted to compare model analyses (multiple regression models) for the Snake River spring chinook and Index Areas/Basins, to account for variable influence and changes in total Index Area production (this would likely include an analysis of standardized regression coefficients, T values, and changes to coefficients of determination and correlation).

- Several different modeling analyses should be conducted. For example, using different time periods--for known periods of high or low ocean productivity--estimated model production values can be derived that should deviate significantly from actual production figures, relative to time periods of counter productivity. Deviations from the model estimates during periods of (known) low ocean productivity would allow for an estimate of ocean impacts, providing for the calculation of an estimated percentage reduction to total production. This type of analysis should be repeated for multiple Index Areas/Basins to confirm the level and range of the observed deviations.

- Statistical analysis techniques should be reviewed and adopted to measure oscillatory trend patterns over time, to compare chinook production trends between the Index Areas and Snake River Basin.

Additional research tasks may be included within the Phase III Analysis given further consideration and discussion with the Corps of Engineers technical staff.

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Cited Figures and Tables

Figures 1a-b.
Comparison of West Coast Chinook Production Index [Ocean Harvest] To Snake River Spring Chinook Escapement

Figure 1a. Snake River Sp. Chin. Escapement Versus West Coast Production Index (Ocean Harvest)

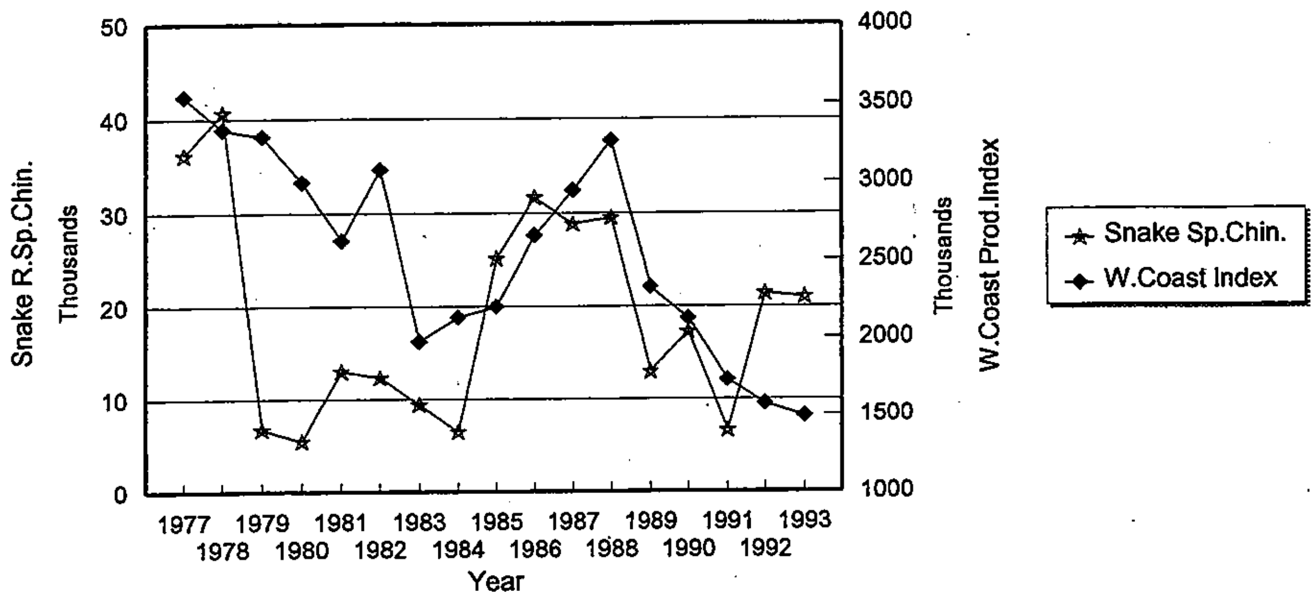

Figure 1b. Snake River Sp. Chin. Escapement Versus West Coast Production Index (Ocean Harvest)

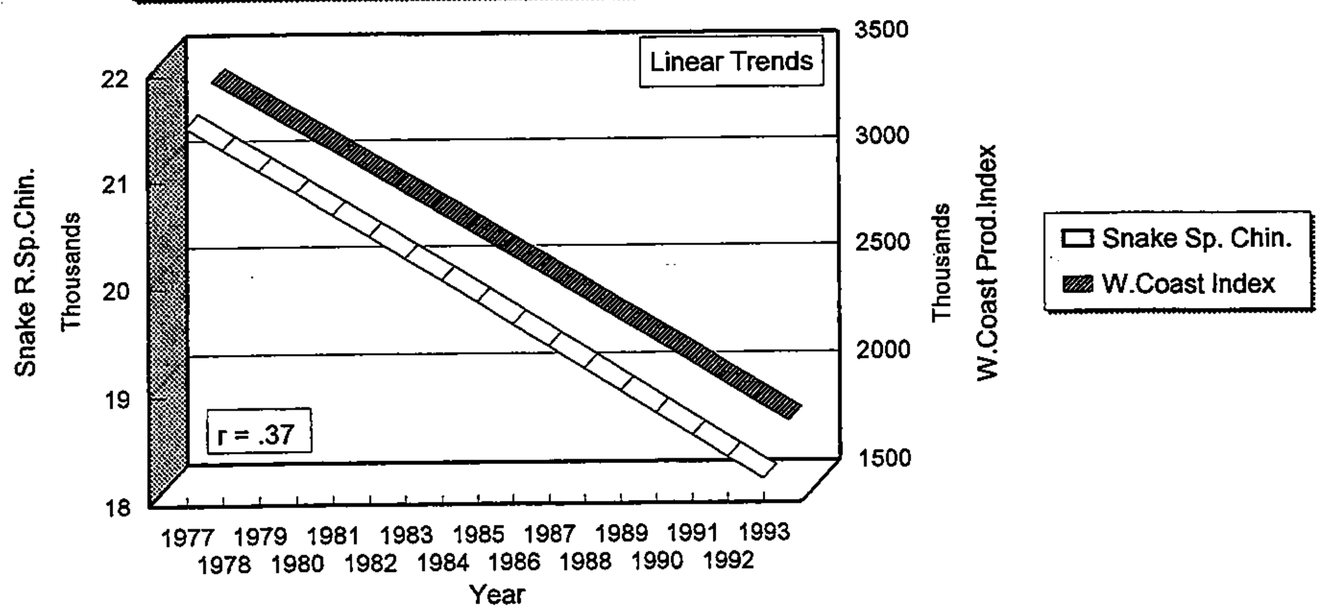

Table 1.
PFMC-Coastwide Chinook Salmon Landings For Ocean Troll and Recreation Fisheries-- Estimated West Coast Production Index (Hatchery and Wild Fish)

Year	PFMC Area	Canada	Southeast Alaska	Total Pacific Coast	Snake R. Sp.Chinook Escapement
1971	1,167,000	1,404,000	349,000	2,920,000	21,800
1972	1,279,000	1,398,000	257,000	2,934,000	38,500
1973	1,960,000	1,314,000	325,000	3,599,000	52,800
1974	1,478,000	1,449,000	339,000	3,266,000	15,500
1975	1,520,000	1,489,000	317,707	3,326,707	16,100
1976	1,414,000	1,755,000	258,762	3,427,762	15,900
1977	1,545,000	1,699,096	302,178	3,546,274	36,200
1978	1,188,000	1,728,150	418,411	3,334,561	40,700
1979	1,337,000	1,571,325	384,606	3,292,931	6,800
1980	1,091,000	1,564,410	343,999	2,999,409	5,500
1981	1,048,000	1,286,679	288,742	2,623,421	13,100
1982	1,425,000	1,336,205	317,314	3,078,519	12,400
1983	569,000	1,096,308	311,766	1,977,074	9,500
1984	490,000	1,350,680	290,076	2,130,756	6,500
1985	884,000	1,037,513	276,413	2,197,926	25,200
1986	1,460,000	913,717	282,410	2,656,127	31,700
1987	1,774,000	887,416	281,887	2,943,303	28,800
1988	2,121,000	861,934	278,891	3,261,825	29,500
1989	1,197,000	840,000	291,000	2,328,000	13,000
1990	915,000	839,000	367,000	2,121,000	17,300
1991	528,000	841,000	357,000	1,726,000	6,600
1992	444,000	871,000	260,000	1,575,000	21,400
1993	532,000	688,200	271,300	1,491,500	21,000

Data Sources: PFMC, "Review of 1993 Ocean Fisheries." Pacific Fishery Management Council, Portland, Oregon, February 1994.

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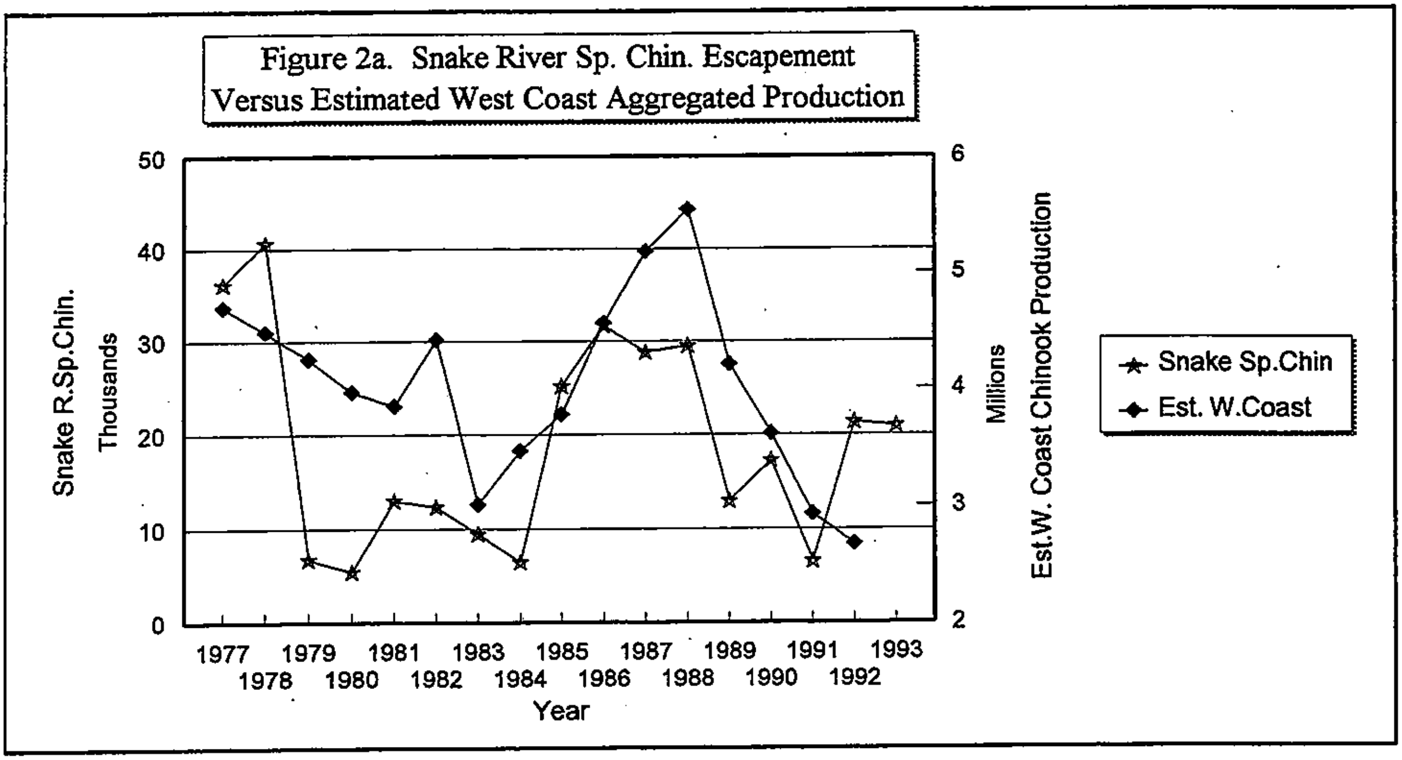
Figures 2a-b.
Comparison of Estimated West Coast Aggregated Production To Snake River Spring Chinook Escapement



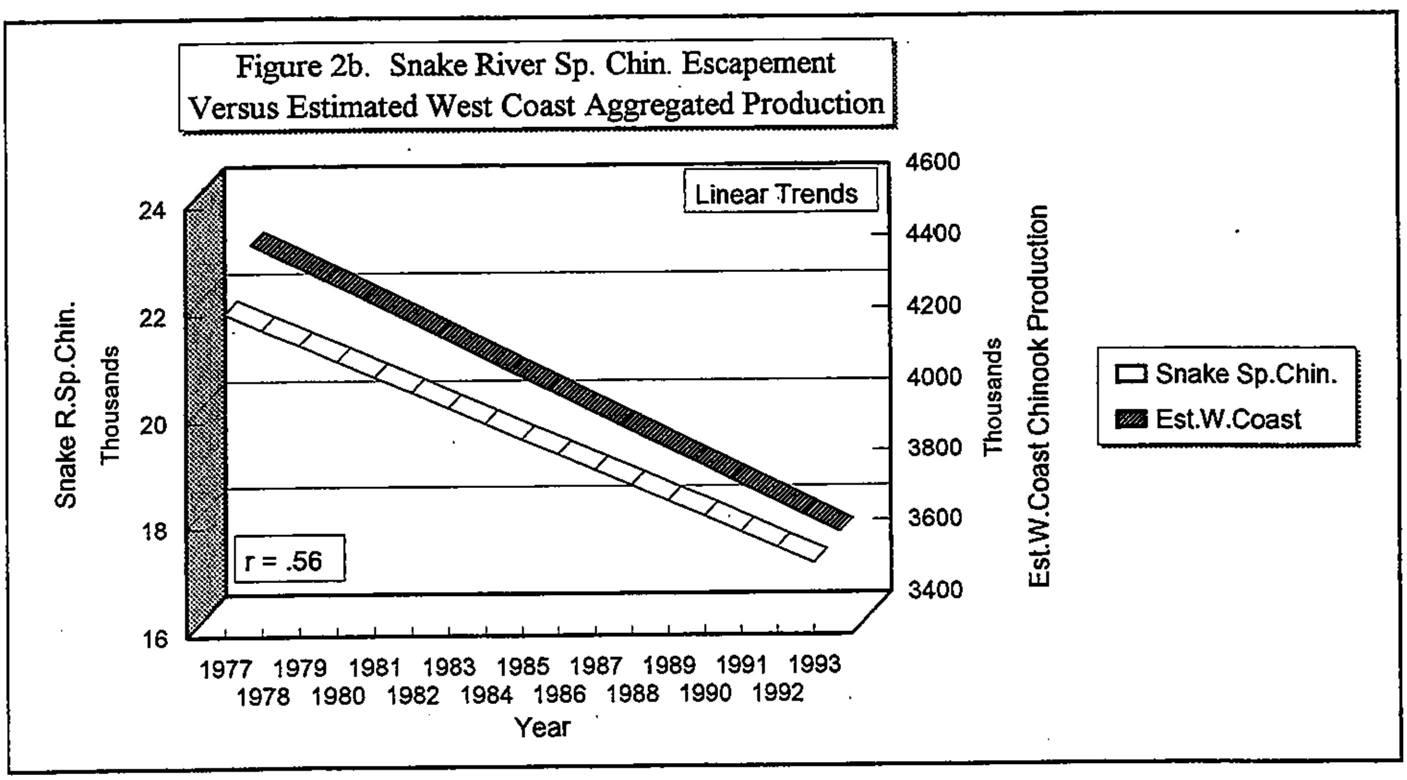


Table 2.
Aggregate1
Estimated West Coast Chinook Salmon Production (Raw Scores Method)

PFMC-Coastwide Chinook Landings For Ocean Troll and Recreation Fisheries and Estimated In-River Chinook Salmon Runs, Escapement and Catch (Hatchery and Wild Fish)

	Ocean Catch (Comm. and Sport)						
Year	PFMC Area	Canada	PFMC Area Canada & SE Alaska	California Central Valley*	Klamath River**	Rogue River*	Oregon Coastal Runs*
1971	1,167,000	1,404,000	2,920,000	252,600	----	23,200	----
1972	1,279,000	1,398,000	2,934,000	145,700	----	25,200	----
1973	1,960,000	1,314,000	3,599,000	254,200	----	30,300	----
1974	1,478,000	1,449,000	3,266,000	241,300	----	13,300	----
1975	1,520,000	1,489,000	3,326,707	206,800	----	17,600	----
1976	1,414,000	1,755,000	3,427,762	212,600	----	15,300	41,200
1977	1,545,000	1,699,096	3,546,274	191,500	----	14,300	56,000
1978	1,188,000	1,728,150	3,334,561	154,000	92,800	44,100	62,500
1979	1,337,000	1,571,325	3,292,931	179,200	51,200	34,500	56,600
1980	1,091,000	1,564,410	2,999,409	187,500	45,600	30,400	44,300
1981	1,048,000	1,286,679	2,623,421	208,000	80,100	18,600	45,500
1982	1,425,000	1,336,205	3,078,519	214,000	66,500	22,600	43,100
1983	569,000	1,096,308	1,977,074	135,200	57,500	9,500	34,300
1984	490,000	1,350,680	2,130,756	215,100	47,100	10,700	42,000
1985	884,000	1,037,513	2,197,926	327,900	64,400	30,900	50,700
1986	1,460,000	913,717	2,656,127	289,300	194,800	74,900	90,200
1987	1,774,000	887,416	2,943,303	213,200	208,800	92,100	104,900
1988	2,121,000	861,934	3,261,825	268,200	191,300	84,900	119,000
1989	1,197,000	840,000	2,328,000	166,000	124,000	61,200	114,400
1990	915,000	839,000	2,121,000	121,800	35,800	23,400	65,000
1991	528,000	841,000	1,726,000	127,400	32,600	13,200	67,300
1992	444,000	871,000	1,575,000	98,100	26,700	6,500	59,600
1993	532,000	688,200	1,491,500	146,300	56,500	24,300	----

Data Sources: PFMC, "Review of 1993 Ocean Fisheries." Pacific Fishery Management Council, Portland, Oregon, February 1994.

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* Spring/Fall Chinook.
** Fall Chinook.
\+ Spring/Summer Chinook.
\++ Spring/Summer/Fall Chinook.

Columbia R. Runs+	Columbia R. Runs**	Willapa Bay Runs**	Grays Harbor Runs+	Grays Harbor Runs**	Queets R. Runs+	Queets R. Runs**
313,300	428,900	----	----	----	----	----
402,500	285,500	----	----	----	----	----
345,200	482,500	----	----	----	----	----
235,800	290,500	----	----	----	----	----
199,400	453,900	----	----	----	----	----
171,300	448,700	23,600	1,000	8,900	700	2,500
264,800	361,300	23,100	1,700	13,600	1,200	5,500
272,600	328,400	21,000	1,600	11,100	1,400	3,100
145,300	296,400	24,200	1,100	12,300	1,600	4,700
153,200	325,500	27,400	600	23,700	1,200	5,800
179,900	297,000	21,000	900	13,400	1,300	8,200
201,300	382,400	16,700	700	14,600	1,400	6,600
167,200	251,900	12,500	900	9,900	1,200	4,400
185,400	322,000	18,700	1,100	23,600	1,200	6,300
192,200	389,000	18,800	1,200	16,900	900	5,900
237,300	507,200	18,800	2,000	20,100	1,200	9,200
266,300	873,500	36,400	1,100	34,400	1,500	10,600
274,200	784,400	71,000	3,600	39,500	2,300	12,500
249,000	546,000	70,400	2,400	55,700	4,000	12,200
275,600	317,300	41,200	1,600	40,600	2,500	13,200
208,900	279,700	46,200	1,500	33,000	800	6,600
210,600	225,900	63,200	1,800	30,300	500	7,000
225,100	216,100	----	----	----	800	5,300

Hoh R. Runs+	Hoh R. Runs**	Quillayute R. Runs+	Quillayute R. Runs**	Puget Sound Production++	Fraser River Terminal Run+	Southern BC Terminal Runs
----	----	----	----	----	----	----
----	----	----	----	----	----	----
----	----	----	----	----	----	----
----	----	----	----	----	----	----
----	----	----	----	----	119,000	24,400
1,300	3,100	6,300	5,100	----	98,700	27,100
2,000	3,800	8,300	9,000	----	132,600	20,400
2,600	2,900	6,800	6,700	----	109,100	21,400
2,300	2,200	5,100	6,800	----	104,600	19,900
1,000	2,800	2,500	8,300	----	69,000	21,600
2,200	4,000	2,300	7,500	380,900	65,700	20,000
2,500	5,900	3,200	10,000	339,300	82,800	21,700
1,800	3,400	2,200	5,800	396,600	73,000	17,700
2,400	2,700	1,500	10,800	440,600	95,900	21,900
1,500	2,800	1,100	8,500	416,500	124,400	16,000
2,500	6,100	1,400	13,800	409,300	145,700	11,400
2,600	6,200	3,800	21,100	320,200	127,600	13,900
3,900	6,900	5,200	22,700	321,200	126,900	18,200
6,600	8,800	6,100	17,700	390,100	107,100	24,500
5,800	6,200	4,400	17,000	412,100	132,800	18,100
1,800	2,600	3,600	7,700	247,000	112,500	25,100
1,400	5,200	3,800	7,900	210,300	105,800	27,700
1,900	3,600	3,700	6,800	----	----	----

Northern BC Terminal Runs	Total Estimated Aggregate West Coast	Total Estimated Aggregate PFMC Area	Snake R. Sp.Chinook Escape.
----	3,938,000	3,565,800	21,800
----	3,792,900	3,510,700	38,500
----	4,711,200	4,355,900	52,800
----	4,046,900	3,694,600	15,500
----	4,347,807	3,869,100	16,100
----	4,495,162	4,095,300	15,900
51,900	4,707,274	4,185,896	36,200
47,600	4,524,261	3,883,650	40,700
38,400	4,279,331	3,697,325	6,800
50,400	4,000,209	3,484,810	5,500
52,200	4,032,121	3,586,879	13,100
45,000	4,558,819	4,069,405	12,400
54,100	3,216,174	2,750,108	9,500
68,200	3,647,956	3,161,180	6,500
89,200	3,956,726	3,419,813	25,200
110,800	4,802,127	4,176,917	31,700
94,200	5,375,703	4,766,016	28,800
118,700	5,736,425	5,108,834	29,500
103,800	4,398,000	3,810,400	13,000
107,100	3,762,500	3,114,100	17,300
93,400	3,036,900	2,435,700	6,600
112,200	2,779,500	2,267,300	21,400
----	----	----	21,000

Figure 2c
West Coast Production Index [Ocean Harvest]
Versus Estimated West Coast Aggregated Production

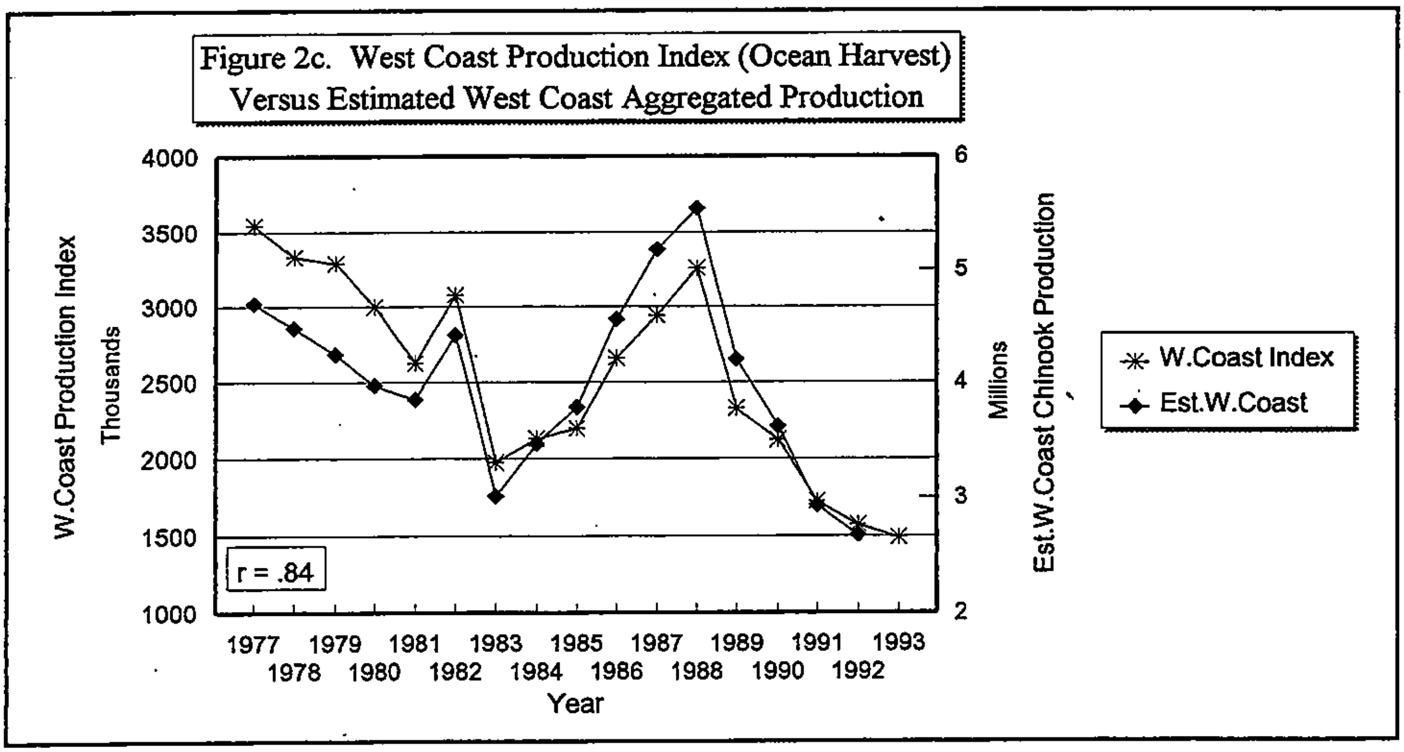
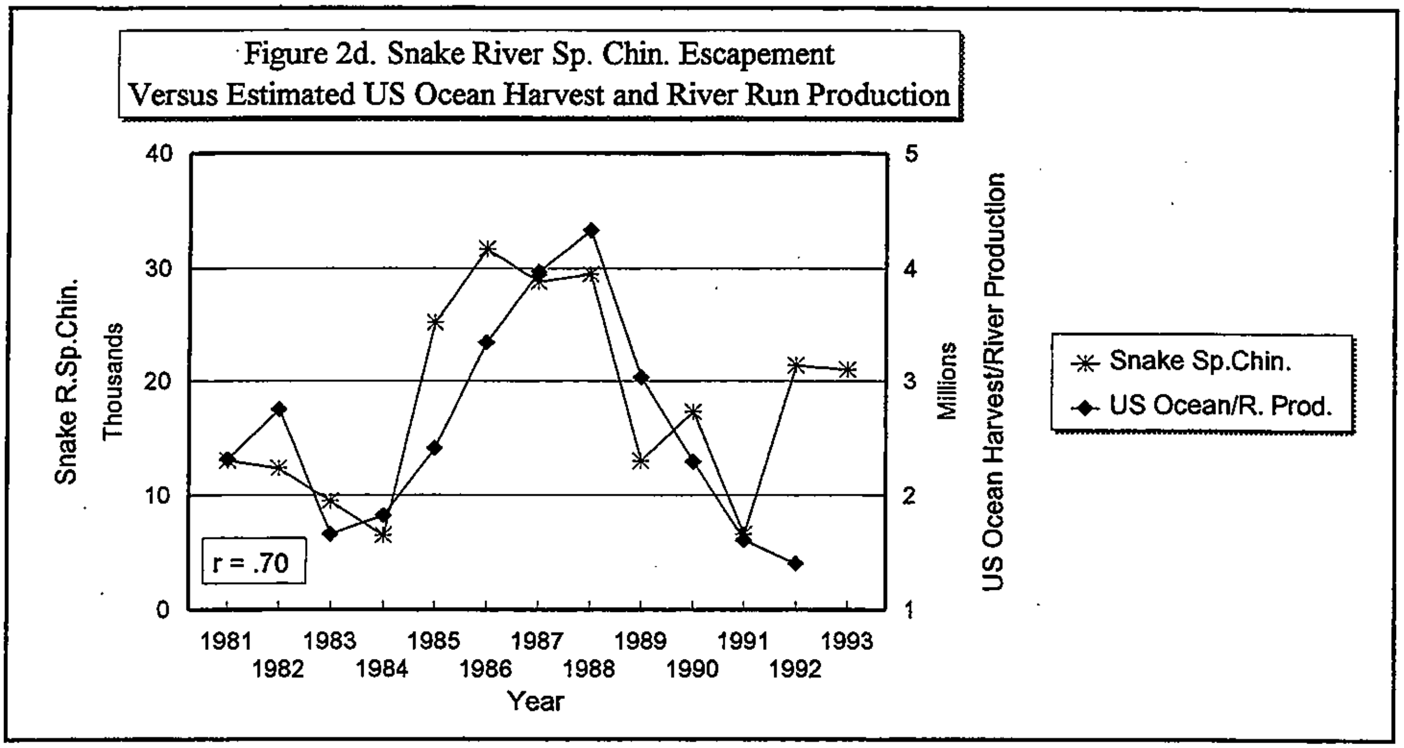
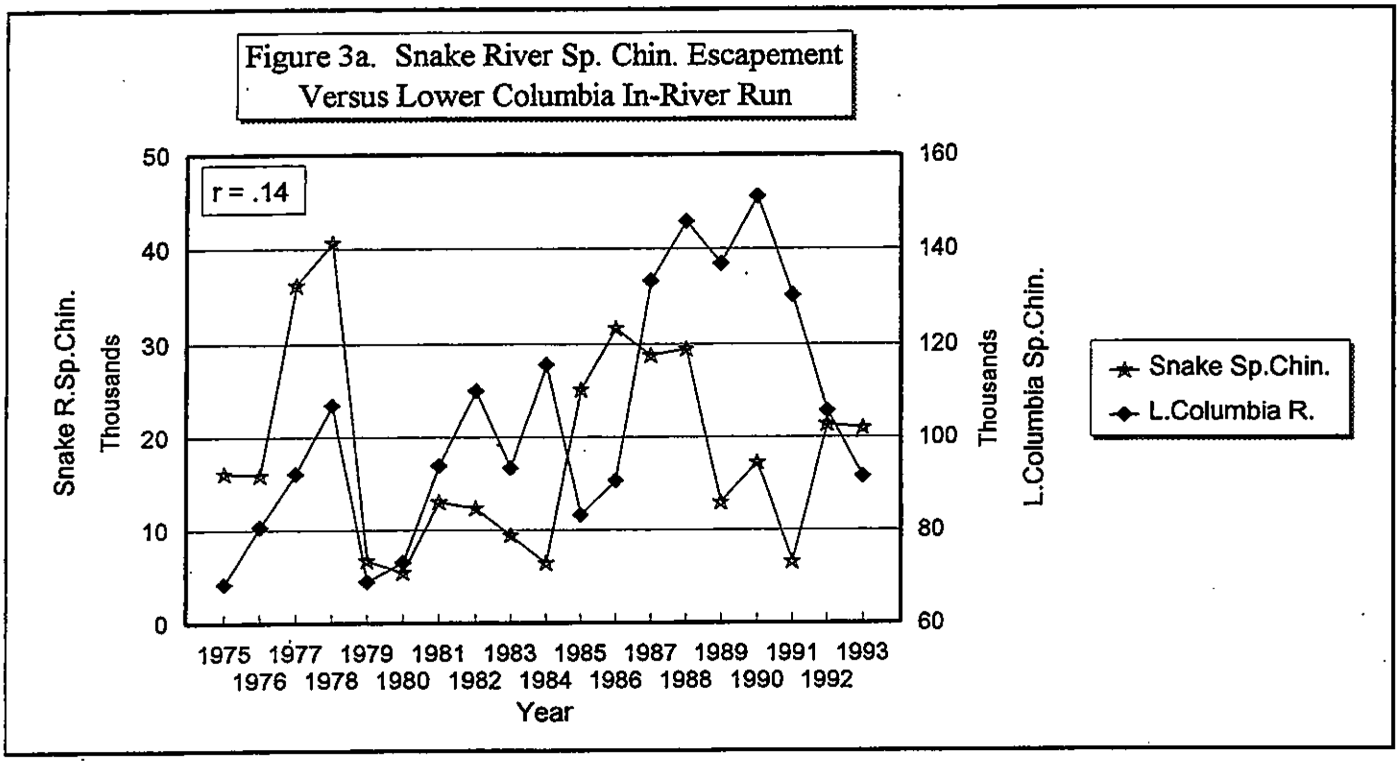


Figure 2d.
Estimated US Ocean Harvest and River Run Production
Versus Snake River Spring Chinook Escapement



Figures 3a-b.
Comparison of Upper and Lower Columbia In-River Spring Chinook Runs To Snake River Spring Chinook Escapement



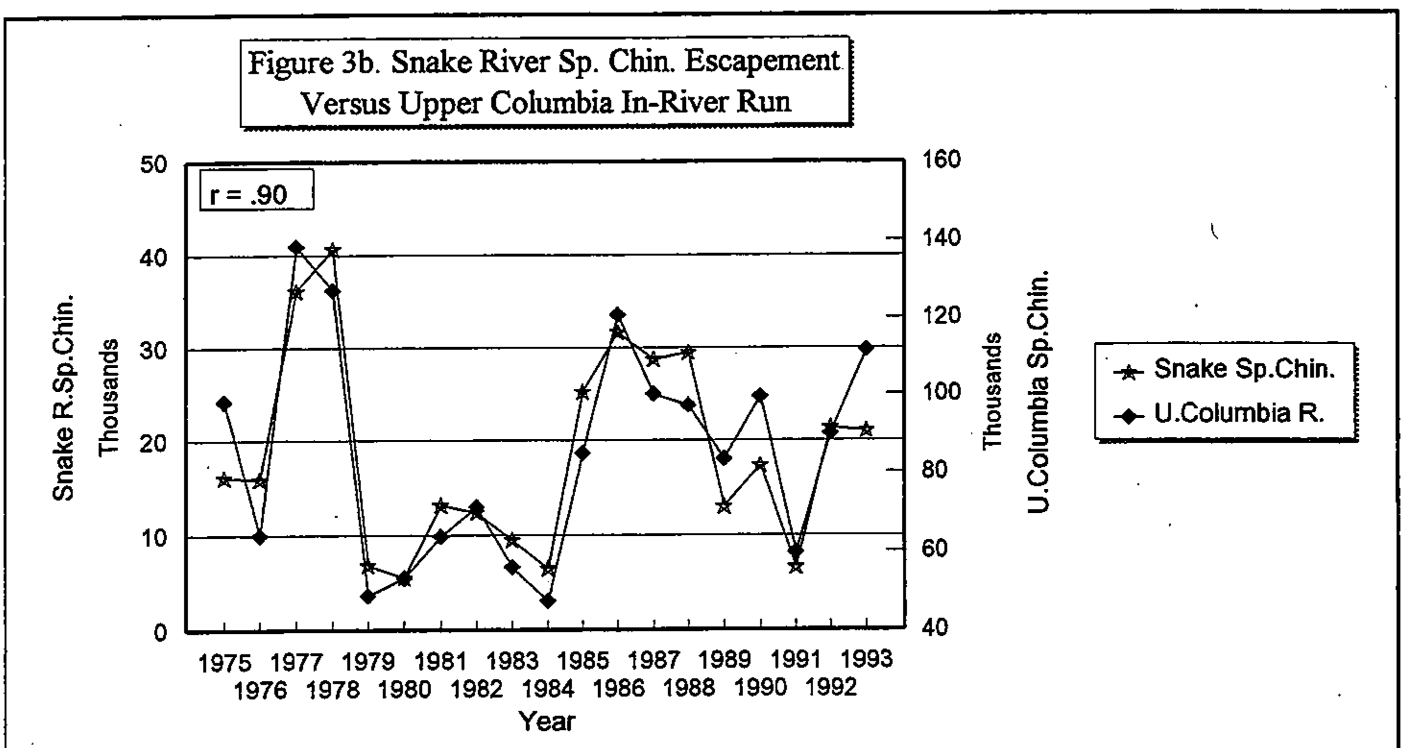


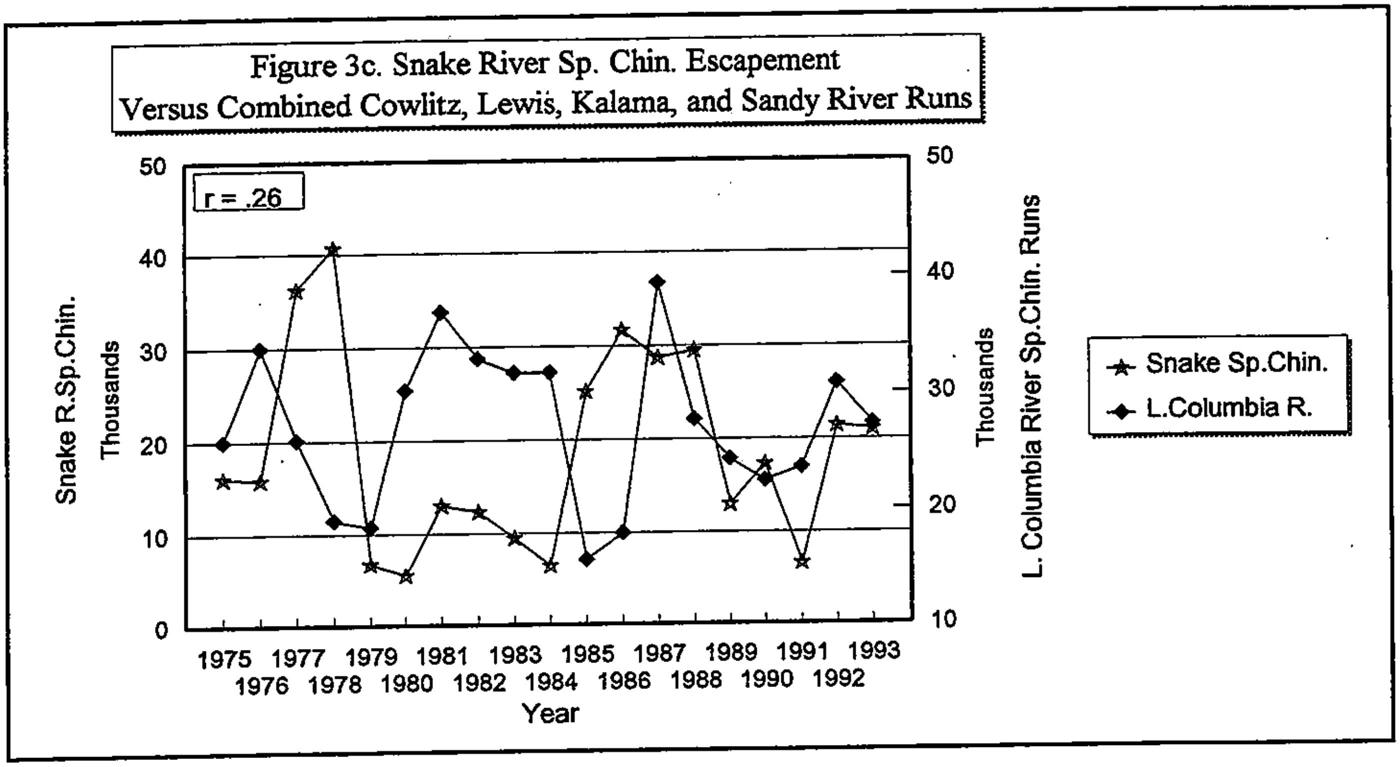
Table 3a.
Columbia River Spring Chinook
Total In-River Run Size for Stocks Destined
Above Bonneville Dam and Upper River Dam Counts
and Lower River Run
(Hatchery and Wild Fish)

Year	Columbia R. Upriver Adults	Bonneville D. Escapement	Snake R. Escapement	Priest Rapids Escapement	Columbia R. Lower R. Adults
1971	146,500	96,800	21,800	5,000	94,900
1972	269,500	136,400	38,500	8,400	65,200
1973	223,800	101,200	52,800	9,000	83,800
1974	99,800	61,900	15,500	10,900	107,100
1975	98,000	97,800	16,100	7,700	68,400
1976	63,900	63,500	15,900	11,500	80,700
1977	138,400	96,800	36,200	20,600	92,100
1978	127,000	119,500	40,700	21,200	106,900
1979	48,600	46,500	6,800	7,400	68,900
1980	53,100	51,300	5,500	8,500	73,100
1981	63,600	59,400	13,100	14,500	93,900
1982	71,100	64,700	12,400	8,700	110,100
1983	55,900	52,400	9,500	10,400	93,300
1984	47,400	43,300	6,500	12,100	115,600
1985	84,700	80,100	25,200	24,100	83,300
1986	120,500	110,600	31,700	21,300	90,600
1987	100,000	91,900	28,800	18,500	133,300
1988	97,000	83,500	29,500	13,100	145,900
1989	83,300	75,000	13,000	11,700	136,900
1990	99,400	87,300	17,300	12,200	151,200
1991	59,700	53,300	6,600	7,700	130,300
1992	89,800	82,700	21,400	19,600	105,700
1993	111,500	103,500	21,000	29,300	91,600

Data Sources: PFMC, "Review of 1993 Ocean Fisheries." Pacific Fishery Management Council, Portland, Oregon, February 1994.

WDF and ODFW, "Status Report: Columbia River Fish Runs & Fisheries, 1938-93." Washington Dept. of Fisheries and Oregon Dept. of Fish & Wildlife, Portland, Oregon, September 1994.

Figures 3c-d.
Comparison of Lower Columbia In-River Runs To Snake River Spring Chinook Escapement



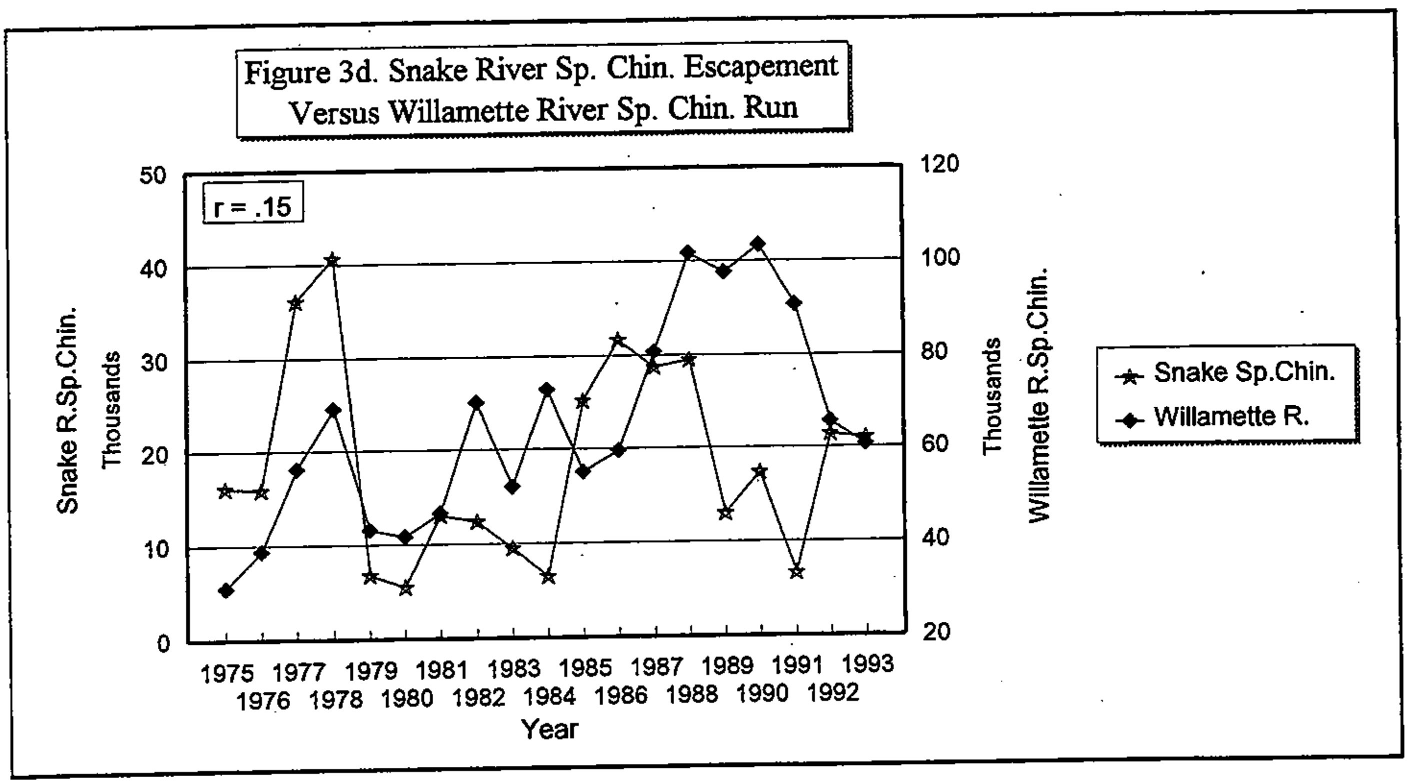


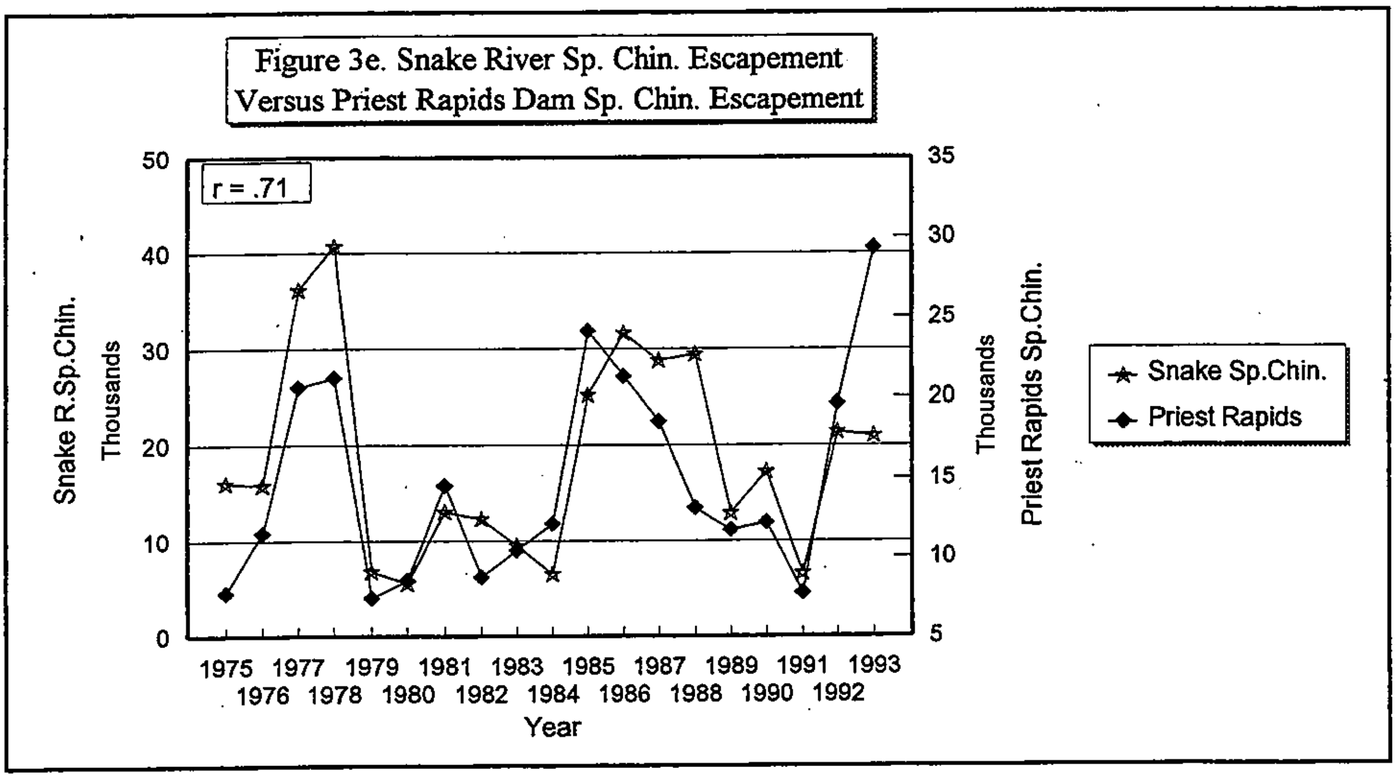
Table 3b.
Columbia River Spring Chinook
Estimated Total In-River Run Size for Stocks
(Hatchery and Wild Fish)

Year	Total Run Willamette Spring Chin.	Total Run Cowlitz Spring Chin.	Total Run Lewis Spring Chin.	Total Run Kalama Spring Chin.	Total Run Sandy Spring Chin.
1971	66,400	8,100	100	500	----
1972	45,500	3,300	100	300	----
1973	52,600	6,500	100	100	----
1974	71,100	19,900	100	500	----
1975	30,900	21,700	400	3,900	----
1976	38,800	26,600	3,100	4,300	----
1977	56,100	20,900	3,300	1,300	600
1978	69,200	13,800	3,700	1,000	700
1979	43,100	13,400	2,500	1,900	800
1980	41,600	23,700	2,300	2,500	1,800
1981	46,600	27,900	3,000	3,300	2,800
1982	70,300	19,300	3,900	8,400	1,400
1983	52,100	21,400	3,700	4,900	1,800
1984	72,900	21,300	6,400	1,800	2,300
1985	55,000	9,900	4,100	300	1,400
1986	59,600	7,300	8,300	1,100	1,300
1987	80,900	18,000	16,600	2,400	2,400
1988	101,800	12,300	10,600	1,900	2,900
1989	97,700	8,300	12,000	2,000	2,000
1990	103,500	7,600	9,300	2,000	3,500
1991	90,900	8,900	8,400	2,600	3,700
1992	65,600	10,200	8,500	2,400	9,700
1993	60,700	10,600	8,200	2,800	5,700

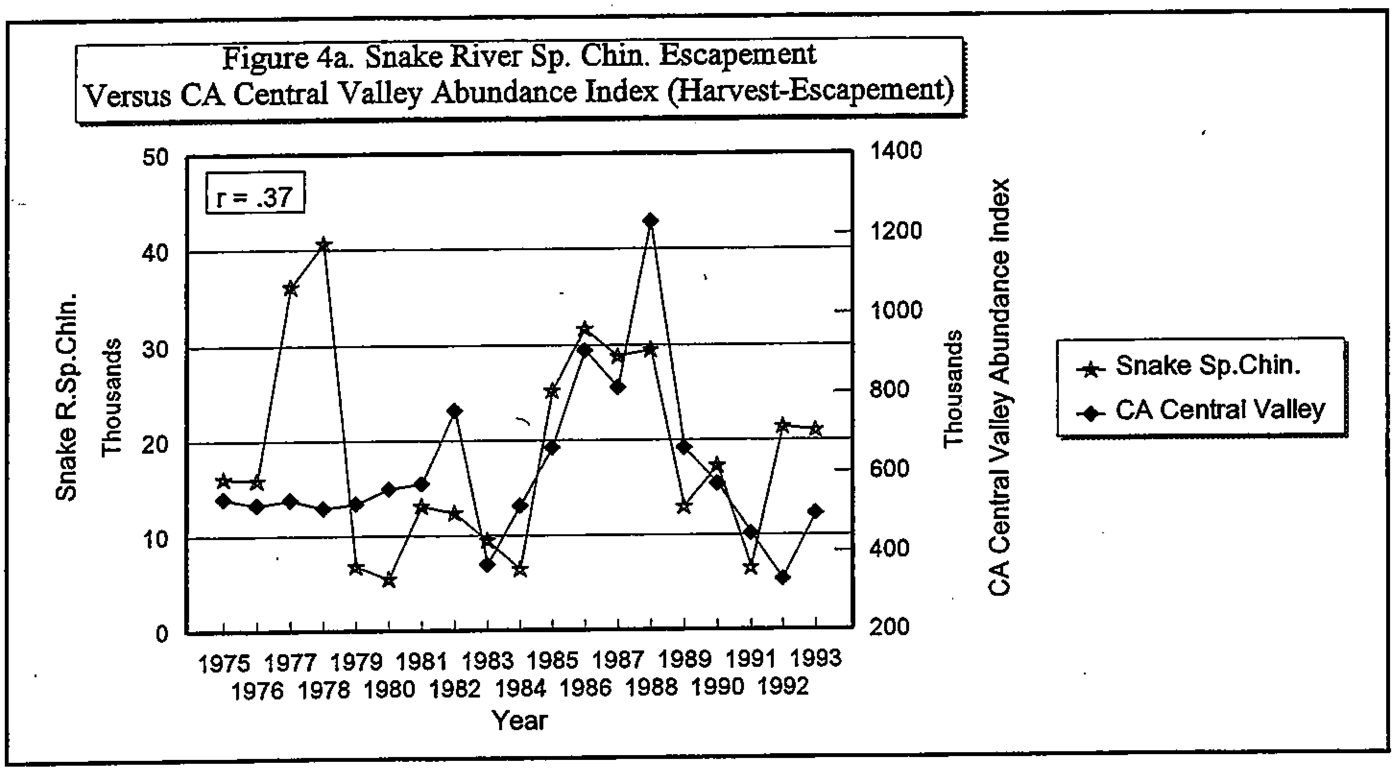
Data Sources: WDF and ODFW, "Status Report: Columbia River Fish Runs & Fisheries, 1938-92." Washington Dept. of Fisheries and Oregon Dept. of Fish & Wildlife, Portland, Oregon, September 1993 (1994 Data Tables from ODFW).

Total Lower Rivers Combined Spring Chin.	Total Lower Rivers Combined Minus Willam. Spring Chin.
75,100	8,700
49,200	3,700
59,300	6,700
91,600	20,500
56,900	26,000
72,800	34,000
82,200	26,100
88,400	19,200
61,700	18,600
71,900	30,300
83,600	37,000
103,300	33,000
83,900	31,800
104,700	31,800
70,700	15,700
77,600	18,000
120,300	39,400
129,500	27,700
122,000	24,300
125,900	22,400
114,500	23,600
96,400	30,800
88,000	27,300

Figure 3e.
Comparison of Priest Rapids Dam Escapement To Snake River Spring Chinook Escapement



Figures 4a-b.
Comparison of California Central Valley Basin Runs To Snake River Spring Chinook Escapement



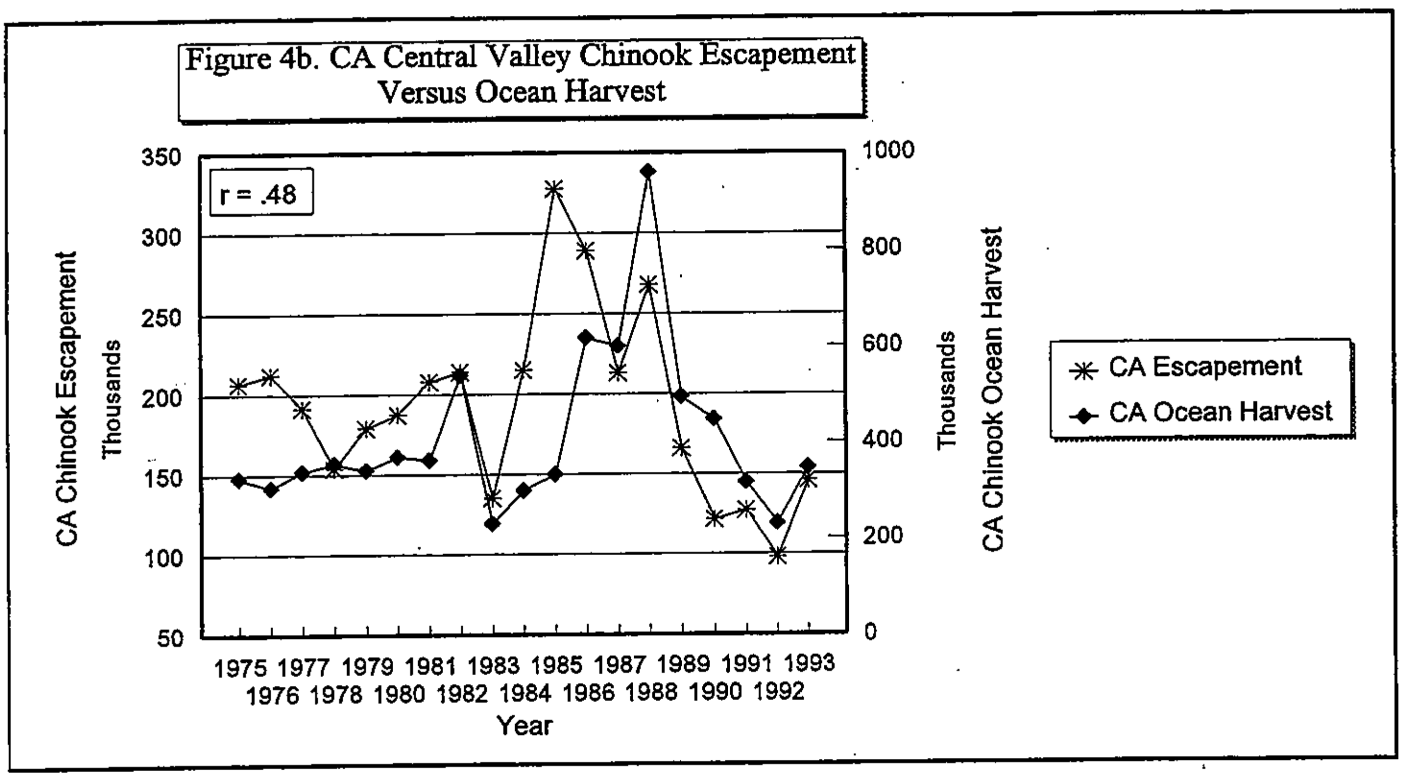


Table 4.
Estimated Fall and Other Chinook Salmon
California Central Valley
(Hatchery and Wild Fish)

Year	CA Central Valley Escapement	CA Central Valley Ocean Landings	CA Central Valley Abun.Index
1971	252,600	317,000	569,600
1972	145,700	417,400	563,100
1973	254,200	603,400	857,600
1974	241,300	424,300	665,600
1975	206,800	327,100	533,900
1976	212,600	306,400	519,000
1977	191,500	340,400	531,900
1978	154,000	356,900	510,900
1979	179,200	342,600	521,800
1980	187,500	371,400	558,900
1981	208,000	363,700	571,700
1982	214,000	540,900	754,900
1983	135,200	231,200	366,400
1984	215,100	300,300	515,400
1985	327,900	334,100	662,000
1986	289,300	617,300	906,600
1987	213,200	599,700	812,900
1988	268,200	960,900	1,229,100
1989	166,000	494,700	660,700
1990	121,800	448,800	570,600
1991	127,400	316,700	444,100
1992	98,100	230,200	328,300
1993	146,300	347,300	493,600

Data Sources: PFMC, "Review of 1993 Ocean Fisheries." Pacific Fishery Management Council, Portland, Oregon, February 1994.

Figures 5a-b.
Comparison of Sacramento/Klamath River Chinook Runs
To Snake/Columbia Chinook Runs

Figure 5a. Upper Snake-Columbia River Sp/Fall Chinook Escapement Versus Sacramento River Fall Chinook Escapement

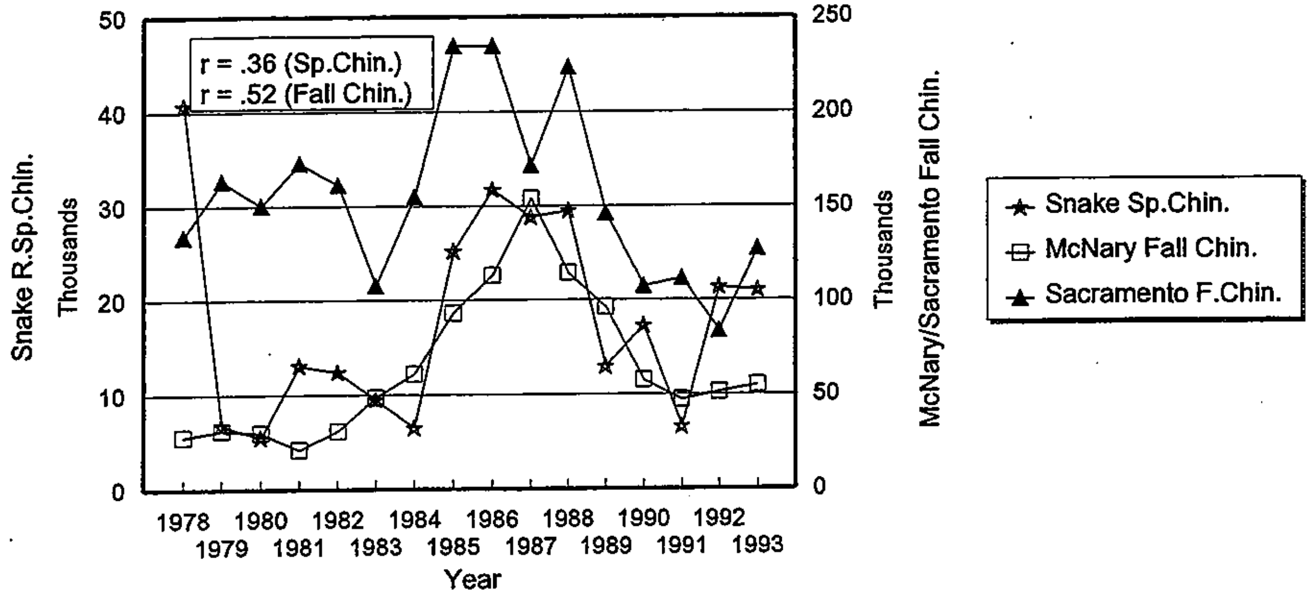


Figure 5b. Upper Snake-Columbia River Sp/Fall Chinook Escapement Versus Klamath River Fall Chinook (In-River Run)

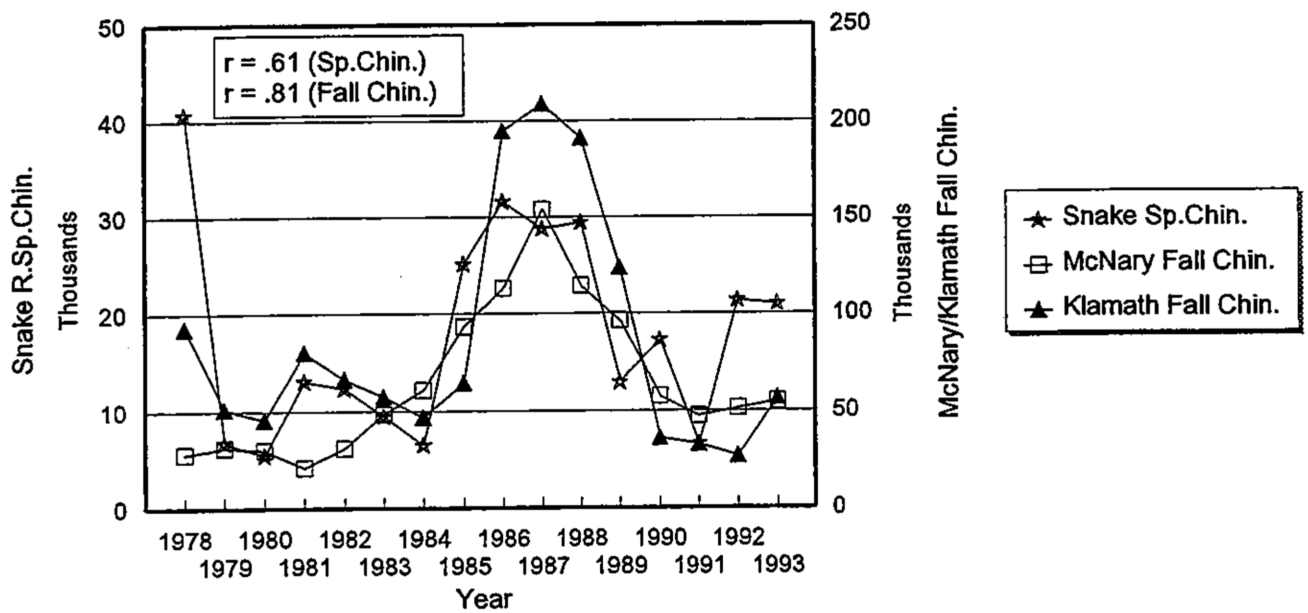


Table 5a.
Estimated Fall Chinook Escapement
Above McNary and Upper River Dams
(Hatchery and Wild Fish)

Year	Upper River Total Run	Snake R. Wild Run	Fall Chin. McNary	Fall Chin. Ice Harbor	Fall Chin. Priest R.
1971	----	----	49,000	9,300	8,500
1972	----	----	37,600	7,500	4,700
1973	----	----	46,600	6,700	4,900
1974	----	----	34,600	2,400	5,000
1975	----	----	29,600	1,900	4,300
1976	115,100	470	28,800	1,100	5,500
1977	95,100	600	37,600	1,200	4,100
1978	85,300	640	27,900	1,100	4,800
1979	89,200	500	31,200	1,200	4,900
1980	76,800	450	29,900	1,200	6,000
1981	66,600	340	21,100	800	3,800
1982	79,000	720	31,100	1,600	8,700
1983	86,100	428	48,700	1,800	8,200
1984	131,400	324	61,000	1,700	7,500
1985	196,400	438	93,300	2,000	11,100
1986	281,500	449	113,300	3,100	19,000
1987	420,600	252	154,100	6,800	35,000
1988	340,000	368	114,700	3,800	22,200
1989	261,100	295	96,500	4,600	14,800
1990	153,400	78	57,600	3,500	6,000
1991	102,700	318	47,200	4,500	4,700
1992	80,700	533	51,200	4,600	4,400
1993	102,900	742	54,900	2,800	7,200

Data Sources: PFMC, "Review of 1993 Ocean Fisheries." Pacific Fishery Management Council, Portland, Oregon, February 1994.

WDF and ODFW, "Status Report: Columbia River Fish Runs & Fisheries, 1938-92." Washington Dept. of Fisheries and Oregon Dept. of Fish & Wildlife, Portland, Oregon, September 1993" (1994 Data Tables from ODFW).

Table 5b.
Estimated Klamath and Sacramento Rivers
Fall Chinook Salmon (Hatchery and Wild Fish)
Total In-River Run

Year	Klamath In-River Run	Klamath Spawning Escapement	Klamath Spawners % of Total	Sacramento Spawning Escapement
1971	----	----	----	149,600
1972	----	----	----	87,400
1973	----	----	----	220,000
1974	----	----	----	200,900
1975	----	----	----	152,600
1976	----	----	----	164,700
1977	----	----	----	147,700
1978	92,800	71,500	77%	134,100
1979	51,200	34,300	67%	163,300
1980	45,600	28,000	61%	150,300
1981	80,100	38,300	48%	172,800
1982	66,500	42,400	64%	161,200
1983	57,500	44,600	78%	108,000
1984	47,100	23,600	50%	155,000
1985	64,400	48,200	75%	235,000
1986	194,800	146,300	75%	235,000
1987	208,800	130,800	63%	171,600
1988	191,300	112,800	59%	223,700
1989	124,000	65,900	53%	146,300
1990	35,800	23,600	66%	107,300
1991	32,600	18,100	56%	111,400
1992	26,700	19,400	73%	83,800
1993	56,500	42,400	75%	127,500

Data Sources: PFMC, "Review of 1993 Ocean Fisheries." Pacific Fishery Management Council, Portland, Oregon, February 1994.

Fall Chinook Spawning Escapement (Adults)

Year	Klamath* Hatchery	Klamath* Natural	Klamath* Total	Sacramento Hatchery	Sacramento Natural	Sacramento Total
1971	----	----	----	11,700	137,900	149,600
1972	----	----	----	8,400	79,000	87,400
1973	----	----	----	21,000	199,000	220,000
1974	----	----	----	12,900	188,000	200,900
1975	----	----	----	12,600	140,000	152,600
1976	----	----	----	10,400	154,300	164,700
1977	----	----	----	17,900	129,800	147,700
1978	13,000	58,500	71,500	11,100	123,000	134,100
1979	3,600	30,600	34,200	15,300	148,000	163,300
1980	6,500	21,500	28,000	25,300	125,000	150,300
1981	4,400	33,900	38,300	30,800	142,000	172,800
1982	10,400	32,000	42,400	30,700	130,500	161,200
1983	13,900	30,800	44,700	17,900	90,100	108,000
1984	7,500	16,100	23,600	37,800	117,200	155,000
1985	22,500	25,700	48,200	26,000	209,000	235,000
1986	32,900	113,400	146,300	22,600	212,400	235,000
1987	29,100	101,700	130,800	21,200	150,400	171,600
1988	33,500	79,400	112,900	26,700	197,000	223,700
1989	22,000	43,900	65,900	25,900	120,400	146,300
1990	8,100	15,600	23,700	22,400	84,900	107,300
1991	6,500	11,600	18,100	24,700	86,700	111,400
1992	7,400	12,000	19,400	21,600	62,200	83,800
1993	21,600	20,900	42,500	24,200	103,300	127,500

* Klamath River includes Trinity River

Figures 6a-b.
Comparison of Rogue River Spring Chinook Escapement
To Snake River Spring Chinook Escapement

Figure 6a. Snake River Sp. Chin. Escapement Versus Rogue River Escapement Above Gold Ray Dam

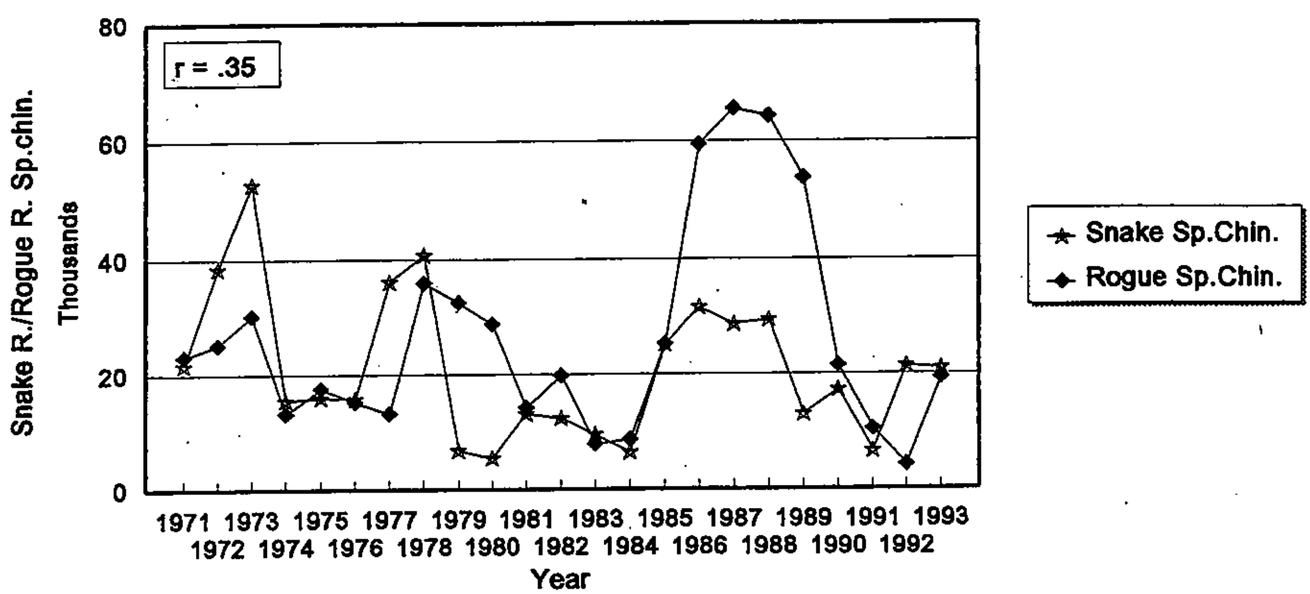


Figure 6b. Rogue River Hatchery Versus Wild Escapement Above Gold Ray Dam

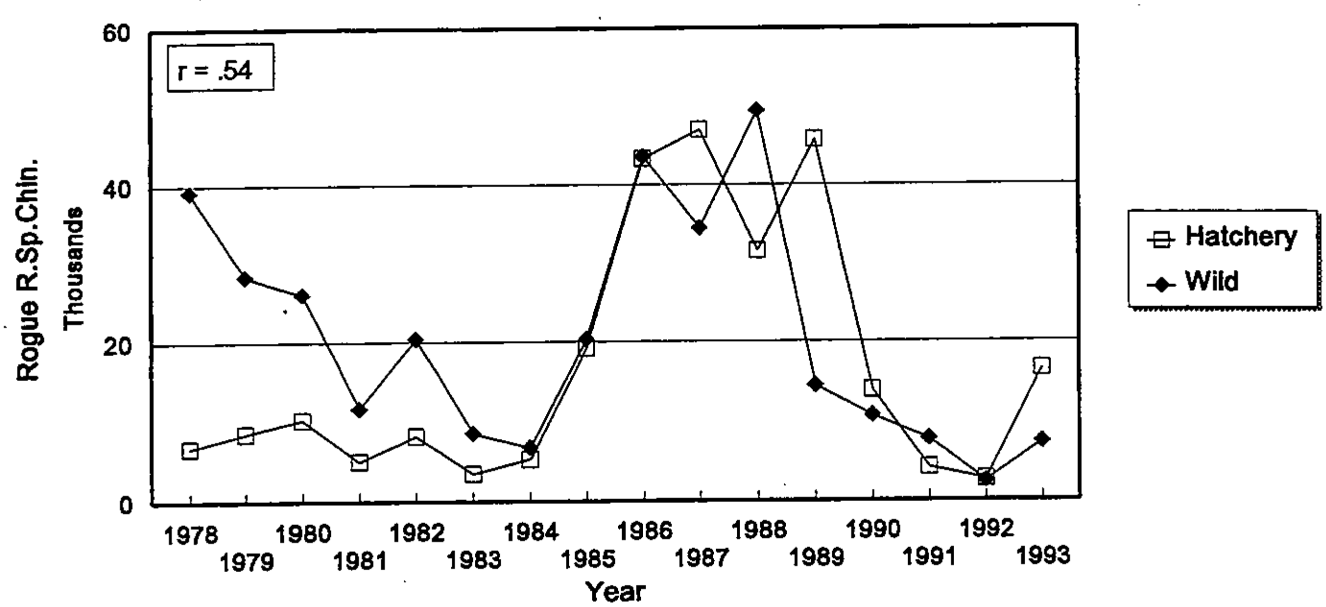


Figure 6c-d.
Comparison of Oregon Coastal Adult
Hatchery Escapement and Freshwater Harvest

Figure 6c. Oregon Coastal Spring Chinook Hatchery Escapement Versus Freshwater Harvest

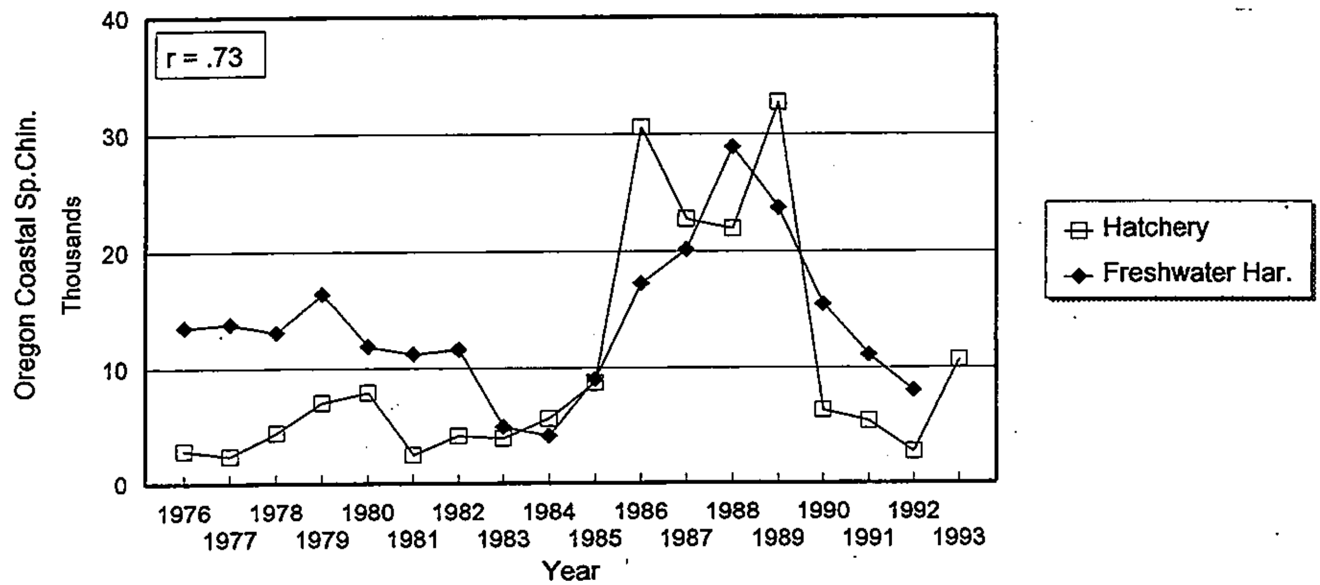


Figure 6d. Oregon Coastal Fall Chinook Hatchery Escapement Versus Freshwater Harvest

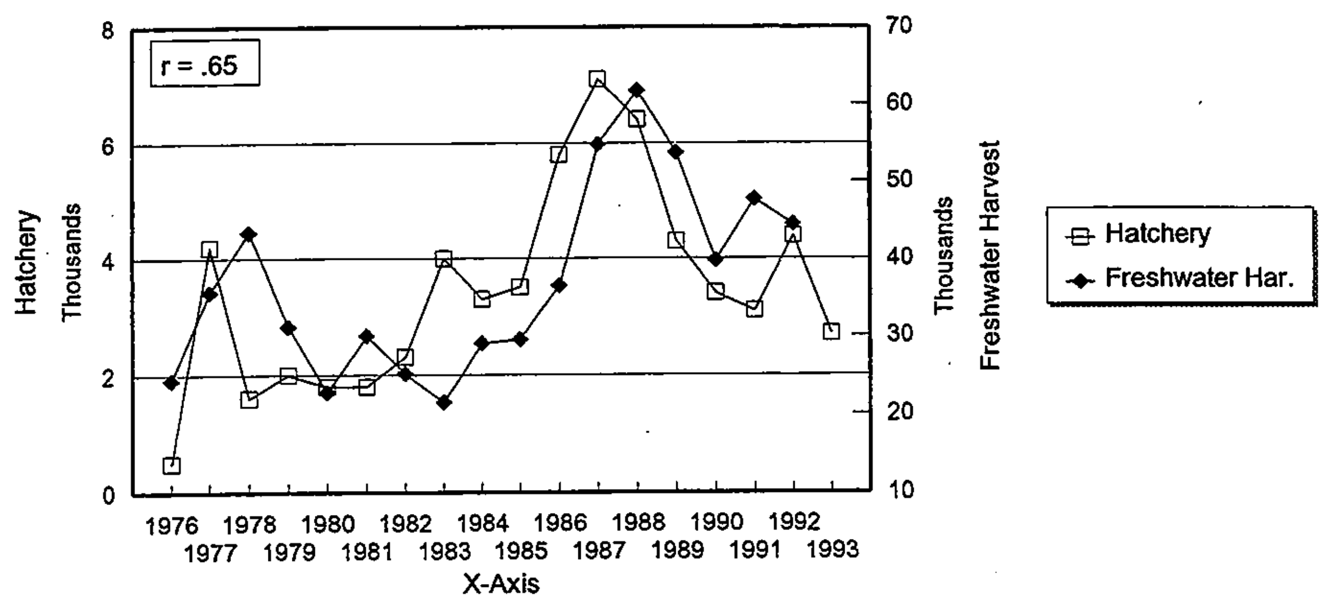


Table 6a.
Spring Chinook Escapement
Above Gold Ray Dam, Rogue River
(Hatchery and Wild Fish)

Fall Chinook Escapement
Based on Carcass Counts
Rogue River

Year	Spr. Chinook Hatchery	Spr. Chinook Wild Fish	Spr. Chinook Adults	Fall Chinook Adults
1971	1,100	28,100	23,200	----
1972	800	29,700	25,200	----
1973	600	34,600	30,300	----
1974	500	16,000	13,300	----
1975	900	20,200	17,600	----
1976	1,100	19,600	15,300	----
1977	1,500	14,800	13,200	1,102
1978	6,800	39,200	35,900	8,165
1979	8,600	28,400	32,600	1,909
1980	10,300	26,100	28,900	1,511
1981	5,100	11,700	14,200	4,404
1982	8,300	20,400	19,800	2,813
1983	3,500	8,600	7,900	1,602
1984	5,300	6,800	8,700	1,997
1985	19,200	20,300	25,400	5,486
1986	43,400	43,600	59,400	15,537
1987	47,100	34,500	65,400	26,742
1988	31,600	49,500	64,200	20,716
1989	45,800	14,500	53,800	7,408
1990	13,900	10,700	21,500	1,868
1991	4,200	7,800	10,400	2,818
1992	2,700	2,500	4,200	2,272
1993	16,500	7,400	19,300	5,000

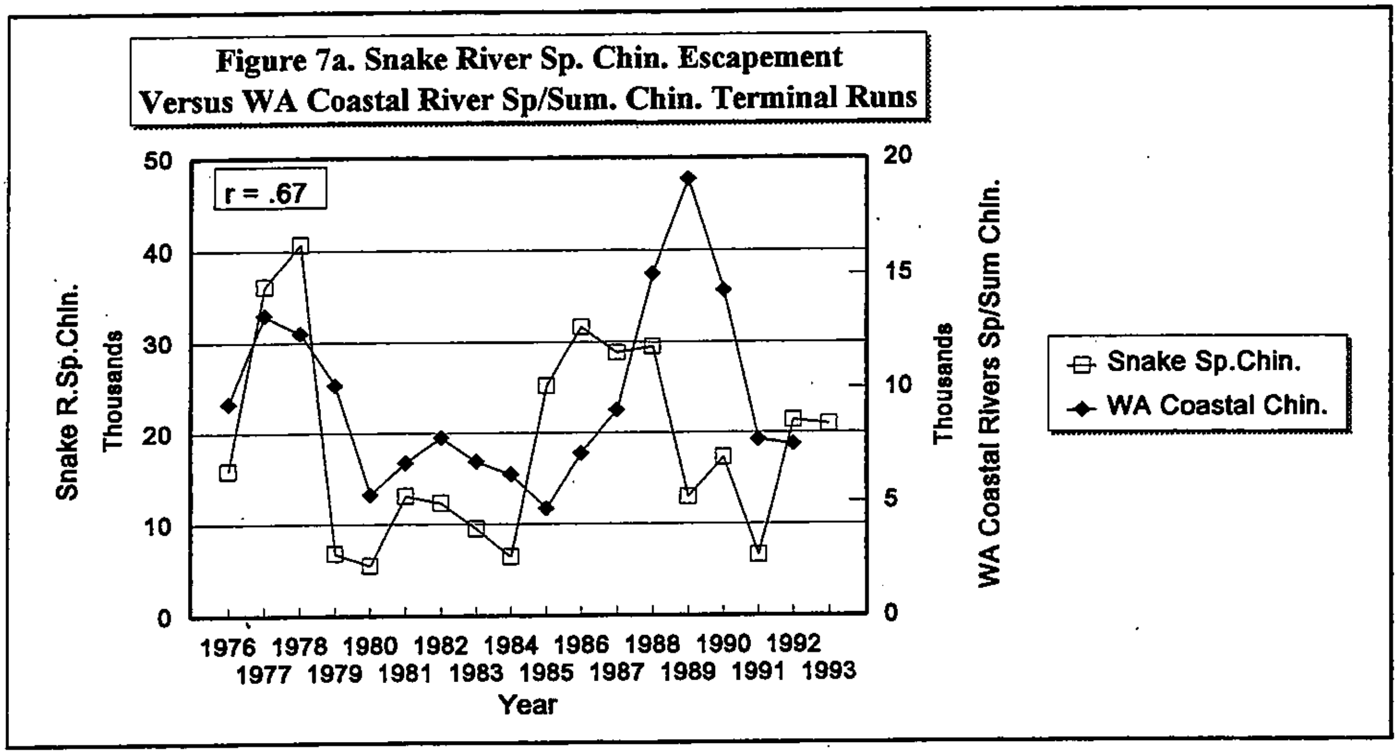
Data Sources: PFMC, "Review of 1993 Ocean Fisheries." Pacific Fishery Management Council, Portland, Oregon, February 1994.

Table 6b.
Oregon Coastal Adult
Spring and Fall Chinook for
Hatchery Escapement and Freshwater Harvest

	Hatchery Return		Freshwater Harvest	
Year	Spring	Fall	Spring	Fall
1976	2,900	500	13,500	24,300
1977	2,400	4,200	13,800	35,600
1978	4,400	1,600	13,100	43,400
1979	7,000	2,000	16,400	31,200
1980	7,900	1,800	11,900	22,700
1981	2,500	1,800	11,200	30,000
1982	4,100	2,300	11,600	25,100
1983	3,900	4,000	4,900	21,500
1984	5,600	3,300	4,100	29,000
1985	8,700	3,500	9,000	29,500
1986	30,600	5,800	17,300	36,500
1987	22,800	7,100	20,200	54,800
1988	22,000	6,400	28,900	61,700
1989	32,700	4,300	23,700	53,700
1990	6,300	3,400	15,500	39,800
1991	5,400	3,100	11,100	47,700
1992	2,700	4,400	8,000	44,500
1993	10,700	2,700	----	----

Source: "Review of 1993 Ocean Salmon Fisheries"; Pacific Fishery Management Council; Portland, Oregon; February 1994

Figures 7a-b.
Comparison of Washington Coastal Rivers
To Snake River Spring Chinook Escapement



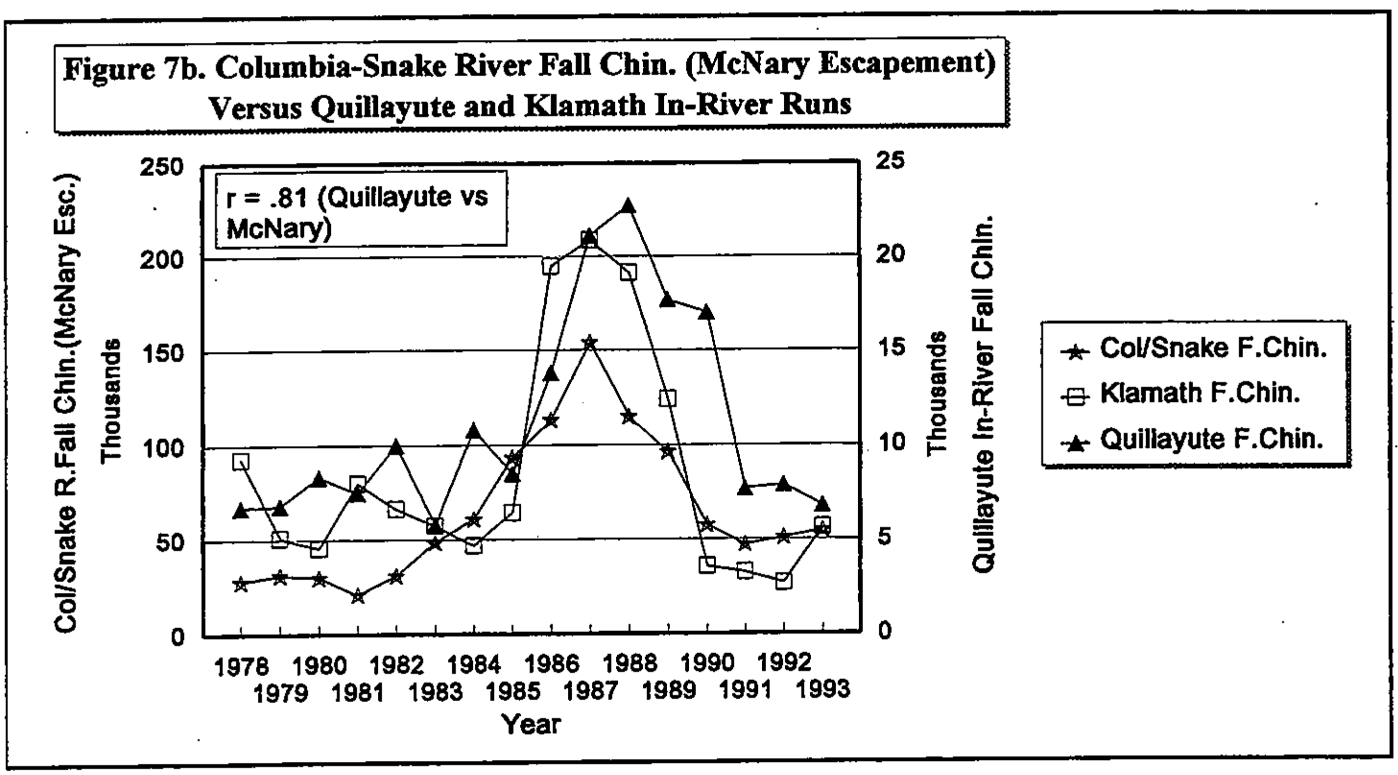
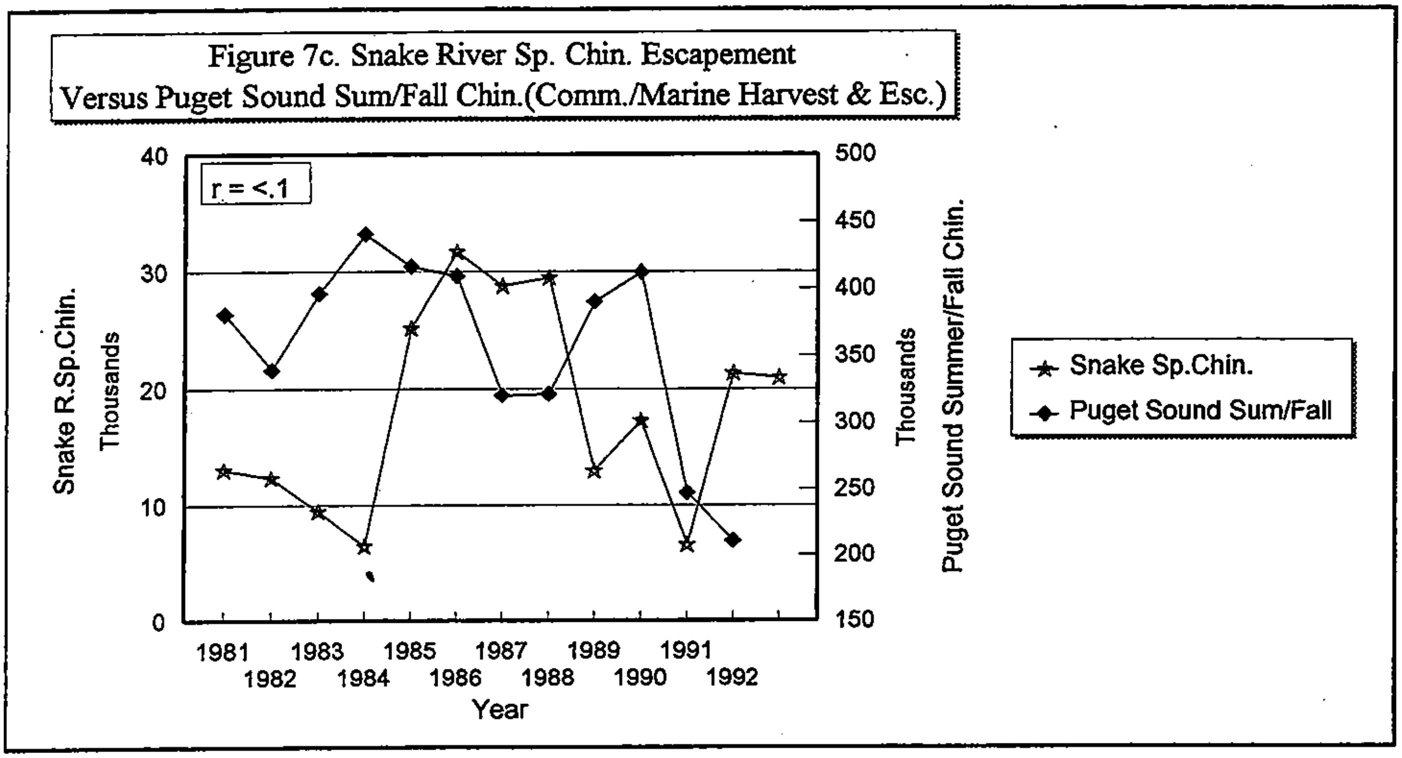


Table 7a.
Washington State Coastal Rivers
Spring/Summer Chinook Terminal Run Size
(Hatchery and Wild Fish)

Year	Queets River	Quillayute River	Hoh River	Grays Harbor	Combined Rivers
1971	----	----	----	----	----
1972	----	----	----	----	----
1973	----	----	----	----	----
1974	----	----	----	----	----
1975	----	----	----	----	----
1976	700	6,300	1,300	1,000	9,300
1977	1,200	8,300	2,000	1,700	13,200
1978	1,400	6,800	2,600	1,600	12,400
1979	1,600	5,100	2,300	1,100	10,100
1980	1,200	2,500	1,000	600	5,300
1981	1,300	2,300	2,200	900	6,700
1982	1,400	3,200	2,500	700	7,800
1983	1,200	2,200	2,450	900	6,750
1984	1,200	1,500	2,400	1,100	6,200
1985	900	1,100	1,500	1,200	4,700
1986	1,200	1,400	2,500	2,000	7,100
1987	1,500	3,800	2,600	1,100	9,000
1988	2,300	5,200	3,900	3,600	15,000
1989	4,000	6,100	6,600	2,400	19,100
1990	2,500	4,400	5,800	1,600	14,300
1991	800	3,600	1,800	1,500	7,700
1992	500	3,800	1,400	1,800	7,500
1993	800	3,700	1,900	----	----

Data Sources: PFMC, "Review of 1993 Ocean Fisheries." Pacific Fishery Management Council, Portland, Oregon, February 1994.

Figures 7c-d.
Comparison of Puget Sound /Fraser Chinook Production
To Snake River Spring Chinook Escapement



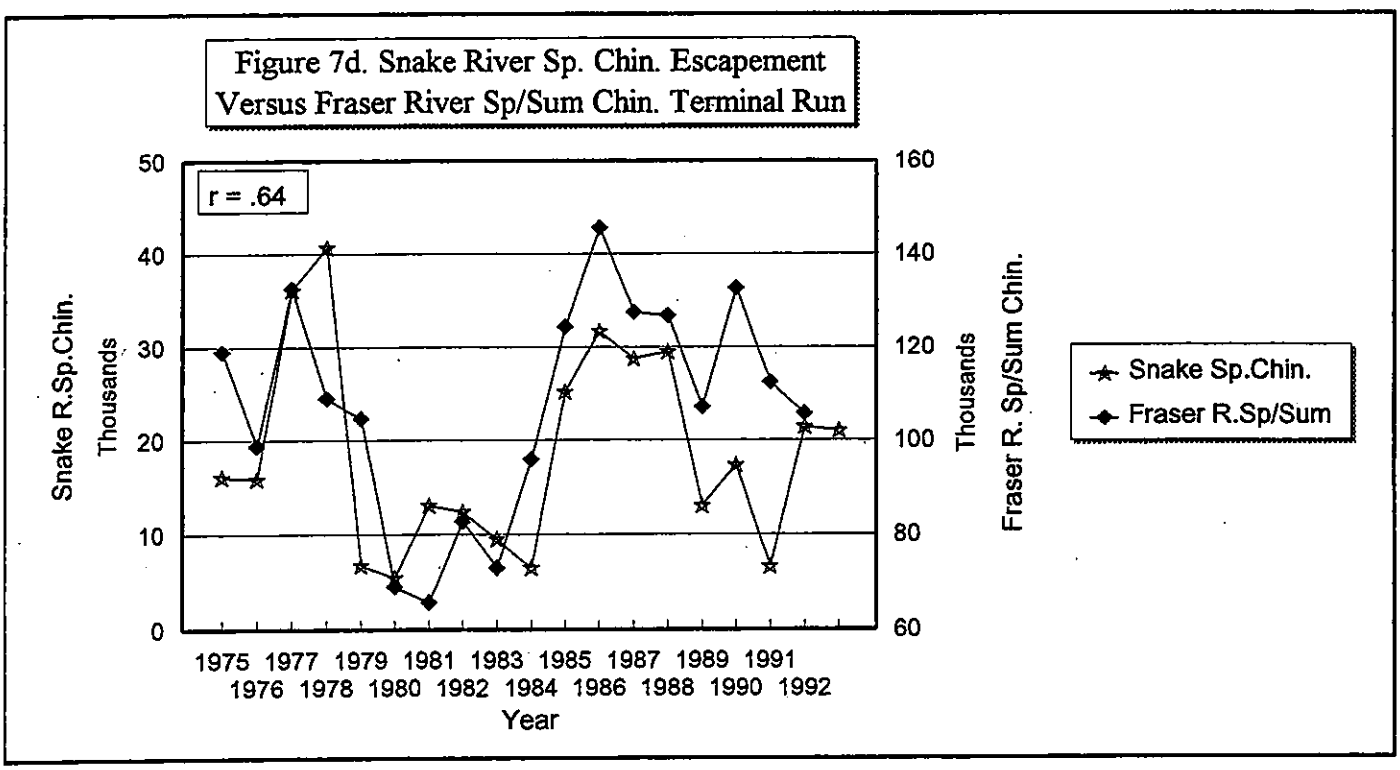


Table 7b.
Fraser River vs. Snake River
Chinook

Year	Puget Sound Run-Rec. Marine Harvest	Puget Sound Run-Comm. Harvest & Escapement	Fraser River Sp/Sm. Chinook Terminal Run	Snake River Sp. Chinook Escapement
1971	----	----	----	21,800
1972	----	----	----	38,500
1973	----	----	----	52,800
1974	----	----	----	15,500
1975	----	----	119,000	16,100
1976	----	----	98,700	15,900
1977	----	----	132,600	36,200
1978	----	----	109,100	40,700
1979	----	----	104,600	6,800
1980	----	----	69,000	5,500
1981	164,400	216,500	65,700	13,100
1982	120,200	219,100	82,800	12,400
1983	194,500	202,100	73,000	9,500
1984	174,600	266,000	95,900	6,500
1985	147,300	269,200	124,400	25,200
1986	170,000	239,300	145,700	31,700
1987	102,900	217,300	127,600	28,800
1988	108,300	212,900	126,900	29,500
1989	135,700	254,400	107,100	13,000
1990	125,500	286,600	132,800	17,300
1991	90,600	156,400	112,500	6,600
1992	97,600	112,700	105,800	21,400
1993	----	----	----	21,000

Sources: 'Pacific Salmon Commission, "Joint Chinook Technical Committee 1992 Annual Report." Vancourver B.C., Report TCCHINOOK (93)-4, November 1993.

WDF and ODFW, "Status Report: Columbia River Fish Runs & Fisheries, 1938-93." Washington Dept. of Fisheries and Oregon Dept. of Fish & Wildlife, Portland, Oregon, September 1994.

Figure 8
Snake River Spring Chinook Escapement
Estimated Wild Versus Hatchery Escapement Above Lower Granite Dam

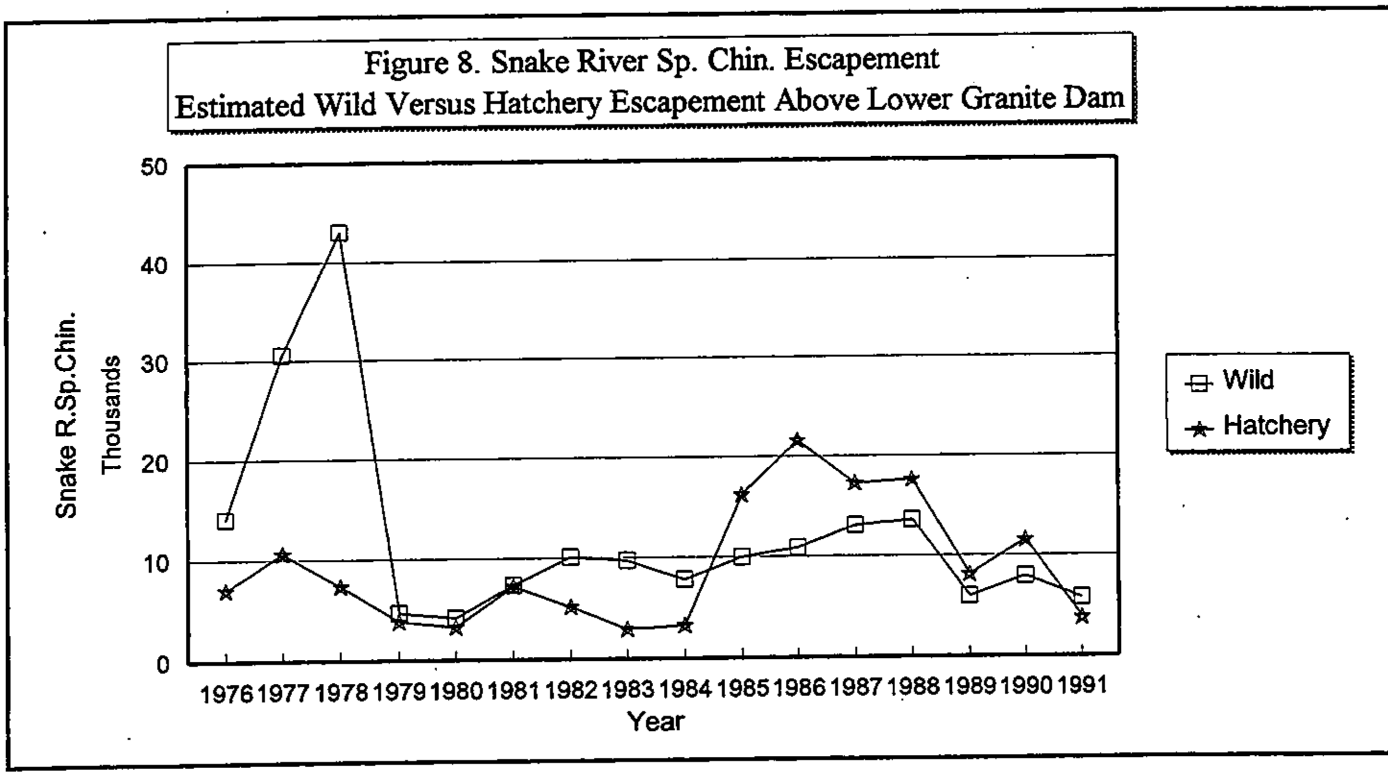


Table 8.
Estimated Wild Versus Hatchery Escapement
Spring and Summer Chinook--Snake River
Spring Chinook--Rogue River

Year	Snake R. Wild	Snake R. Hatchery	Rogue R. Wild	Rogue R. Hatchery
1976	14,112	7,031	19,600	1,100
1977	30,569	10,665	14,800	1,500
1978	43,084	7,373	39,200	6,800
1979	4,695	3,844	28,400	8,600
1980	4,155	3,236	26,100	10,300
1981	7,378	7,218	11,700	5,100
1982	10,153	5,157	20,400	8,300
1983	9,745	2,924	8,600	3,500
1984	7,822	3,263	6,800	5,300
1985	9,978	16,233	20,300	19,200
1986	10,892	21,587	43,600	43,400
1987	13,113	17,290	34,500	47,100
1988	13,559	17,665	49,500	31,600
1989	5,977	8,118	14,500	45,800
1990	7,964	11,555	10,700	13,900
1991	5,742	3,752	7,800	4,200
1992	----	----	2,500	2,700
1993	----	----	7,400	16,500

Data Sources: PFMC, "Review of 1993 Ocean Fisheries." Pacific Fishery Management Council, Portland, Oregon, February 1994.

PNUCC, Estimated Spring/Summer Chinook Escapement Above Lower Granite Dam, Comments on the 1992 Biological Assessment for Snake-Columbia River Operations (Spread Sheet Analysis Includes Wild Fish Counts at Hatchery Sites), December 1992; Personal Communication with Richard Turner, PNUCC Biologist, December 1992-January 1993.

Appendix A.
Chinook Salmon Escapement Goals/Trends

Appendix A1. Summary Table
Escapement Goal Summary Table

River System or Stock Escapement	Years Data Available	Stock or Goal Type	Hatchery Wild Or Total	Number of years that current excapement of the goal met percentage of the goal: Over 100%	80% to 99%	60% to 79%	40% to 59%	20% to 39%	10% to 19%	Less than 10%
California										
Central Valley	1970-93	Fall	Total	19	3	2				
San Joaquin	1970-93	Fall	Hatch					5	10	9
Columbia River										
Bonneville Dam	1976-93	Spring	Total	1	4	5	7	1		
Bonneville Dam	1976-93	Summer	Total			1	2	14	1	
Snake River	1976-93	Spring	Total	2	3	3	2	4	4	
Washington Coast										
Willapa Bay	1981-93	Fall	Hatch	8	1	2	2			
Grays Harbor	1981-92	Spring	Wild	5	2	2	3			
Grays Harbor	1981-92	Fall	Wild	6	1	2	1	2		
Queets	1976-93	Spr/Su	Wild	14	2	1	1			
Queets	1976-93	Fall	Wild	16	1		1			
Hoh	1976-93	Spr/Su	Wild	15	2	1				
Hoh	1976-93	Fall	Wild	18						
Quillayute	1976-93	Fall	Wild	17	1					
Puget Sound										
Str. Jaun de Fuca	1981-92	Su/Fall	Total	3	2	2	4	1		
Nooksak-Samish	1981-92	Su/Fall	Hatch	9	1	2				
Skagit	1981-92	Su/Fall	Wild	3	2	3	4			
Hood Canal	1981-92	Su/Fall	Hatch	9	1	1		1		
Stillaguamish-Snohom.	1981-92	Su/Fall	Wild		2	6	4			
South Puget Sound	1981-92	Su/Fall	Total		12					
Fraser River										
Upper Fraser	1975-92	Spring	Wild	7	2	2	4	3		
Middle Fraser	1975-92	Spr/Su	Wild	6	1	6	4	1		
Thompson	1975-92	Summer	Wild		2	7	5	4		
Harrison	1984-92	Fall	Wild			3	2	3	1	
Southern B.C.										
West Coast Van. Is.	1975-92	Fall	Wild			3	9	4	2	
Lower Geo. Str.	1975-92	Fall	Wild				11	5	2	
Upper Geo. Str.	1975-92	Su/Fall	Wild	6	2	6	1	3		
Northern B.C.										
Nass	1975-92	Spr/Su	Wild	1		6	8	3		
Skeena	1975-92	Spr/Su	Wild	8	1	1	7	1		

Appendix A1. Summary Table (Continued)

S.E. Alaska and and Transboundary Rivers										
Bossom	1975-92	Spring	Wild	2	1	2	3	3	5	2
Keta	1975-92	Spring	Wild	9	1	2	4	1	1	
Taku	1975-92	Spring	Wild		2	4	5	5	2	
Stikine	1975-92	Spring	Wild	4	5		4	4	1	

Data Source: PFMC, "Review of 1993 Ocean Fisheries." Pacific Fishery Management Council, Portland, Oregon, February 1994.

Snake River and Upper Columbia Escapement
Spring and Summer Chinook

			Snake River Spring Chinook		Snake River Summer Chinook		Upper Columbia Total (1)	
Year	Total Esc.	% of Goal	Wild Esc.	% of Goal	Total Esc.	Wild Esc.	Spring	Summer
1971-75	28.9	83%	----	----	13.2	13.2	8.2	14.6
1976	15.9	45%	----	----	7.0	7.0	11.5	17.2
1977	36.2	103%	----	----	7.7	7.7	20.6	16.3
1978	40.7	116%	----	----	11.6	11.6	21.2	19.2
1979	6.8	19%	4.8	19%	2.7	2.7	7.4	20.3
1980	5.5	16%	2.2	9%	2.7	2.7	8.5	16.0
1981	13.1	37%	5.4	22%	3.3	3.3	14.5	11.6
1982	12.4	35%	6.4	26%	4.2	3.5	8.7	8.8
1983	9.5	27%	6.2	25%	3.9	3.2	10.4	8.5
1984	6.5	19%	3.3	13%	5.4	4.2	12.1	16.2
1985	25.2	72%	6.0	24%	5.1	3.2	24.1	15.9
1986	31.7	91%	7.9	32%	6.2	3.9	21.3	16.2
1987	28.8	82%	8.9	36%	5.9	2.4	18.5	14.1
1988	29.5	84%	10.9	44%	6.1	2.3	13.1	13.4
1989	13.0	37%	3.9	16%	3.2	2.4	11.7	19.7
1990	17.3	49%	4.2	17%	5.1	3.4	12.2	15.6
1991	6.6	19%	2.7	11%	3.8	2.8	7.7	14.8
1992	21.4	61%	8.2	33%	3.0	1.1	19.5	8.5
1993	21.0	60%	6.2	25%	7.9	4.0	29.3	16.4
Goal	35.0		25.0					

Note: (1) Count at the upper most dam (Little Goose in 1971-74 and Lower Granite after 1974).

California Central Valley
Fall Chinook

	Sacramento River				San Joaquin River			Total California Central Valley	
Year	Natural Esc.	Hatchery Esc.	Total Esc.	% of Goal(2)	Natural Esc.	Hatchery Esc.	% of Goal	Fall	Other(1)
1971-75	----	----	----	----	----	----	----	----	45.7
1976-80	-----	----	----	----	----	----	----	----	32.4
1970	147.0	13.2	160.2	131%	30.0	0.3	5%	191	----
1971	137.9	11.7	149.6	123%	40.0	1.0	18%	191	----
1972	79.0	8.4	87.4	72%	12.0	0.2	4%	100	----
1973	199.0	21.0	220.0	180%	6.5	0.6	11%	227	----
1974	188.0	12.9	200.9	165%	3.7	1.0	18%	206	----
1975	140.0	12.6	152.6	125%	5.8	0.8	15%	159	----
1976	154.3	10.4	164.7	135%	3.5	0.6	11%	169	----
1977	129.8	17.9	147.7	121%	0.6	0.4	7%	149	----
1978	123.0	11.1	134.1	110%	2.3	0.5	9%	137	----
1979	148.0	15.3	163.3	134%	4.0	0.6	11%	168	----
1980	125.0	25.3	150.3	123%	5.0	0.6	11%	156	----
1981	142.0	30.8	172.8	142%	15.9	0.6	11%	189	38.3
1982	130.5	30.7	161.2	132%	14.0	2.0	36%	177	27.8
1983	90.1	17.9	108.0	89%	11.1	1.9	35%	121	20.9
1984	117.2	37.8	155.0	127%	40.8	1.7	31%	198	12.3
1985	209.0	26.0	235.0	193%	72.6	1.3	24%	309	23.1
1986	212.4	22.6	235.0	193%	23.2	0.8	15%	259	24.2
1987	150.4	21.2	171.6	141%	15.8	0.6	11%	188	22.3
1988	197.0	26.7	223.7	183%	20.7	0.4	7%	245	30.3
1989	120.4	25.9	146.3	120%	3.2	0.1	2%	150	19.8
1990	84.9	22.4	107.3	88%	0.9	0.1	2%	108	13.1
1991	86.7	24.7	111.4	91%	0.6	0.3	5%	112	12.1
1992	62.2	21.6	83.8	69%	1.1	0.4	7%	85	12.8
1993	103.3	24.2	127.5	105%	2.3	1.7	31%	132	----
Goal			122.0 to 180.0			5.5			

Note: (1) Late-fall, winter and spring chinook.
(2) Percent of minimum of escapement range of 122,000 fish.

Klamath River Escapement
Fall Chinook

Year	Hatchery Esc.	Wild Esc.	Total Esc.
1978	13.0	58.5	71.5
1979	3.6	30.6	34.3
1980	6.5	21.5	28.0
1981	4.4	33.9	38.3
1982	10.4	32.0	42.4
1983	13.9	30.8	44.6
1984	7.5	16.1	23.6
1985	22.5	25.7	48.2
1986	32.9	113.4	146.3
1987	29.1	101.7	130.8
1988	33.5	79.4	112.8
1989	22.0	43.9	65.9
1990	8.1	15.6	23.6
1991	6.5	11.6	18.1
1992	7.4	12.0	19.4
1993	21.6	20.9	42.4

Oregon Coastal Returns
Spring Chinook

Year	Rogue River Hatchery Returns Spring	Rogue River Hatchery Returns Fall	Rogue River Gold Ray Dam Natural	Rogue River Gold Ray Dam Hatchery	Umpqua River Winchester Dam Natural	Umpqua River Winchester Dam Hatchery
1970	----	----	----	----	6.1	6.9
1971	----	----	28.1	1.1	6.0	3.9
1972	----	----	29.7	0.8	7.9	8.5
1973	----	----	34.6	0.6	11.4	8.2
1974	----	----	16.0	0.5	5.8	5.1
1975	----	----	20.2	0.9	5.4	5.2
1976	2.9	0.5	19.6	1.1	5.5	5.2
1977	2.4	4.2	14.8	1.5	6.8	5.5
1978	4.4	1.6	39.2	6.8	5.4	2.8
1979	7.0	2.0	28.4	8.6	5.5	4.0
1980	7.9	1.8	26.1	10.3	5.7	1.9
1981	2.5	1.8	11.7	5.1	4.6	4.1
1982	4.1	2.3	20.4	8.3	6.5	2.0
1983	3.9	4.0	8.6	3.5	3.0	2.9
1984	5.6	3.3	6.8	5.3	4.5	2.4
1985	8.7	3.5	20.3	19.2	7.5	6.1
1986	30.6	5.8	43.6	43.4	8.3	5.3
1987	22.8	7.1	34.5	47.1	9.3	6.3
1988	22.0	6.4	49.5	31.6	7.8	3.8
1989	32.7	4.3	14.5	45.8	7.6	2.2
1990	6.3	3.4	10.7	13.9	5.5	2.0
1991	5.4	3.1	7.8	4.2	2.4	1.8
1992	2.7	4.4	2.5	2.7	2.5	2.5
1993	10.7	2.7	7.4	16.5	3.8	2.1

Escapement to areas below Bonneville Dam
Spring Chinook

Year	Willamette River Run Size	Willamette River Escapement	Willamette River % of Goal(2)	Lewis River Escapement	Cowlitz River Escapement
1971-75	53.0	34.3	87%	0.2	11.9
1976	38.8	21.0	143%	3.1	26.6
1977	56.1	38.5	78%	3.3	20.9
1978	69.2	45.7	66%	3.7	13.8
1979	43.0	25.5	118%	2.5	13.4
1980	41.6	26.4	114%	2.3	23.7
1981	46.6	28.6	105%	3.0	27.9
1982	70.2	45.1	67%	3.9	19.3
1983	52.0	28.7	105%	3.7	21.4
1984	73.4	42.4	71%	6.4	21.3
1985	55.6	33.1	91%	4.1	9.9
1986	59.7	37.3	80%	8.3	7.3
1987	81.9	52.8	57%	16.6	18.0
1988	101.9	68.7	44%	10.6	12.3
1989	97.5	65.9	46%	12.0	8.3
1990	103.5	69.1	43%	9.3	7.7
1991	90.9	48.7	62%	8.4	8.9
1992	65.6	39.7	76%	9.2	10.2
1993	60.7	29.7	101%	9.8	10.6
Goal		7.0 (1)			

Notes: (1) Prior to 1988. the escapement goal at Willamette Falls was 30,000 to 35,000. Beginning in 1988, the goal is dependent on run size under the Willamette Basin Fish Management Plan. Under the plan, the escapement target is 30,000 adults above Willamette Falls at Willamette River run sizes (run entering the Columbia River) of 70,000 or less and increases linearly (5,000 per each 10,000 of increased run size) to 45,000 at Willamette River run sizes of 100,000 or greater.

(2) Percentage of goal is based on the minimum escapement of 30,000.

Columbia River Escapement
Adult Spring Chinook

	Bonneville Dam		Snake River		Upper(1)	Upper	Lower
		% of		% of	Columbia	River	River
Year	Esc.	Goal	Esc.	Goal	Esc.	Hatchery	Hatchery
1971-75	98.8	86%	28.9	83%	8.2	13.4	20.1
1976	63.5	55%	15.9	45%	11.5	14.8	29.9
1977	96.8	84%	36.2	103%	20.6	20.1	30.2
1978	119.5	104%	40.7	116%	21.2	14.4	25.2
1979	46.5	40%	6.8	19%	7.4	9.3	19.2
1980	51.3	45%	5.5	16%	8.5	11.2	28.4
1981	59.4	52%	13.1	37%	14.5	15.2	33.8
1982	64.7	56%	12.4	35%	8.7	15.7	31.1
1983	52.4	46%	9.5	27%	10.4	16.4	27.0
1984	43.3	38%	6.5	19%	12.1	13.7	33.1
1985	80.1	70%	25.2	72%	24.1	30.6	19.2
1986	110.6	96%	31.7	91%	21.3	37.2	19.9
1987	91.9	80%	28.8	82%	18.5	33.8	33.1
1988	83.5	73%	29.5	84%	13.1	28.1	34.9
1989	75.0	65%	13.0	37%	11.7	22.7	35.5
1990	87.3	76%	17.3	49%	12.2	34.9	38.9
1991	53.3	46%	6.6	19%	7.7	17.5	30.2
1992	82.7	72%	21.4	61%	19.5	30.8	29.7
1993	103.5	90%	21.0	60%	29.3	38.3	26.9
Goal	115.0		35.0				

Note: (1) Priest Rapids Dam count.

Columbia River Escapement
Adult Summer Chinook

Year	Bonneville Dam Esc.	Bonneville Dam % of Goal(1)	Snake River Escapement Total	Snake River Escapement Wild	Upper(1) Columbia Escapement
1971-75	43.3	54%	13.2	13.2	14.6
1976	26.6	33%	7.0	7.0	17.2
1977	33.3	42%	7.7	7.7	16.3
1978	37.6	47%	11.6	11.6	19.2
1979	26.7	33%	2.7	2.7	20.3
1980	25.8	32%	2.7	2.7	16.0
1981	21.1	26%	3.3	3.3	11.6
1982	18.8	24%	4.2	3.5	8.8
1983	17.7	22%	3.9	3.2	8.5
1984	22.1	28%	5.4	4.2	16.2
1985	23.2	29%	5.1	3.2	15.9
1986	25.7	32%	6.2	3.9	16.2
1987	31.8	40%	5.9	2.4	14.1
1988	30.2	38%	6.1	2.3	13.4
1989	28.7	36%	3.2	2.4	19.7
1990	25.0	31%	5.1	3.4	15.6
1991	18.8	24%	3.8	2.8	14.8
1992	15.0	19%	3.0	1.1	8.5
1993	21.6	27%	7.9	4.0	16.4

Goal 80.0-90.0

Note: (1) Percent calculated using lower end of excapement goal of 80,000 fish.

Washington Coastal Returns
Chinook Salmon

	Willapa Bay Fall Chinook			Grays Harbor Spring Chinook		Grays Harbor Fall Chinook		
Year	Natural	Hatchery	%	Natural	%	Natural	%	Hatchery
1976-80	3.2	5.6	66%	0.6	43%	6.5	45%	0.3
1981-85	3.4	6.1	72%	0.9	64%	6.0	41%	0.8
1986-90	13.2	14.6	172%	2.0	143%	20.2	138%	0.7
1981	2.8	4.2	49%	0.6	43%	7.6	52%	0.8
1982	2.7	4.6	54%	0.6	43%	5.6	38%	0.4
1983	3.1	6.2	73%	0.8	57%	5.5	38%	0.6
1984	5.4	9.5	112%	1.1	79%	21.0	144%	0.9
1985	3.2	6.1	76%	1.2	86%	9.4	64%	1.1
1986	3.0	7.7	91%	2.0	143%	10.5	72%	1.2
1987	5.9	21.7	255%	0.9	64%	18.8	129%	1.8
1988	18.0	17.4	205%	3.5	250%	28.2	193%	0.2
1989	26.4	17.6	207%	2.1	150%	26.1	179%	--
1990	12.5	8.7	102%	1.5	107%	17.5	120%	0.4
1991	7.5	11.5	135%	1.3	93%	14.4	99%	0.4
1992	13.1	12.2	144%	1.7	121%	16.9	116%	0.9
1993	----	13.0	153%	----		----		0.5
Goal		8.5		1.4		14.6		

Washington Coastal Returns (Continued)
Chinook Salmon

	Queets River Spr/Summer			Queets River Fall			Hoh River Spr/Summer			Hoh River Fall		
Year	Nat'l	%	Hatch	Nat'l	%	Hatch	Nat'l	%	Hatch	Nat'l	%	Hatch
1776-80	0.9	129%	(2)	2.8	112%	-	1.0	111%	-	2.1	175%	-
1981-85	0.9	129%	(2)	3.8	152%	0.4	1.5	167%	0.1	2.7	225%	(1)
1976	0.5	71%	-	1.2	48%	-	0.6	67%	-	2.5	208%	-
1977	0.7	100%	-	3.6	144%	-	1.0	111%	-	2.1	175%	-
1978	1.1	157%	-	2.2	88%	-	1.4	156%	-	1.9	158%	-
1979	0.9	129%	0.1	3.9	156%	-	1.4	156%	-	1.7	142%	-
1980	1.0	143%	-	3.2	128%	-	0.8	89%	-	2.2	183%	-
1981	1.0	143%	-	4.3	172%	0.1	1.5	167%	(1)	3.1	258%	-
1982	0.8	114%	0.1	4.1	164%	0.2	1.6	178%	0.1	4.5	375%	(1)
1983	1.0	143%	(2)	2.6	104%	0.3	1.8	200%	0.1	2.5	208%	(1)
1984	1.0	143%	-	3.9	156%	0.6	1.5	167%	-	1.9	158%	(1)
1985	0.7	100%	-	3.7	148%	0.6	1.0	111%	0.1	1.7	142%	(1)
1986	0.9	129%	-	7.8	312%	0.2	1.5	167%	-	5.0	417%	(1)
1987	0.6	86%	-	6.5	260%	0.2	1.7	189%	-	4.0	333%	(1)
1988	1.8	257%	-	8.4	336%	1.3	2.6	289%	-	4.1	342%	(1)
1989	2.6	371%	-	8.7	348%	0.8	4.0	444%	0.1	5.1	425%	(1)
1990	1.8	257%	-	10.1	404%	0.6	3.9	433%	(1)	4.2	350%	(1)
1991	0.6	86%	-	4.5	180%	0.5	1.1	122%	-	1.4	117%	(1)
1992	0.4	57%	-	4.7	188%	0.4	0.8	89%	-	4.0	333%	-
1993	0.7	100%	-	2.7	108%	0.6	1.2	133%	(1)	2.0	167%	-
Goal	0.7			2.5			0.9			1.2		

Notes: (1) Less than 50 fish.
(2) Goal for summer chinook only.

Washington Coastal Returns (Continued)
Chinook Salmon

	Quillayute River Spr./Summer		Quillayute River Fall		
Year	Natural	Hatchery	Natural	%	Hatchery
1976-80	2.1	0.8	4.2	140%	0.1
1981-85	0.9	0.3	6.3	210%	0.1
1976	1.3	1.8	2.5	83%	0.1
1977	3.8	0.9	3.3	110%	0.2
1978	2.3	0.7	4.7	157%	0.3
1979	2.1	0.2	3.9	130%	0.1
1980	0.9	0.4	6.7	223%	(1)
1981	0.8	0.3	6.0	200%	0.1
1982	1.2	0.1	7.1	237%	0.1
1983	1.4	0.2	3.1	103%	0.1
1984	0.6	0.4	9.1	303%	0.1
1985	0.6	0.3	6.1	203%	(1)
1986	0.6	0.3	10.0	333%	0.1
1987	0.6	1.5	12.4	413%	0.2
1988	1.3	1.2	15.2	507%	0.2
1989	2.4	1.2	10.0	333%	0.1
1990	1.5	0.9	13.7	457%	(1)
1991	1.2	0.8	6.3	210%	(1)
1992	1.0	1.5	6.3	210%	(1)
1993	1.3	0.9	6.0	200%	(1)
Goal	1.5 (2)		3.0		

Notes: (1) Less than 50 fish.
(2) Goal for summer Chinook only.

Puget Sound Spawning Escapements
Summer/Fall Chinook

	Str. of Juan de Fuca				Nooksack/Samish				Skagit			
Year	Hatch	Wild	Total	% of Goal	Hatch	% of Goal	Wild	Total	Hatch	Wild	% of Goal	Total
1981-85	0.8	1.4	2.3	43%	16.1	185%	6.5	22.6	0.8	11.5	77%	12.3
1986-90	1.3	4.5	5.8	109%	10.7	123%	4.1	14.9	0.8	12.7	85%	13.6
1981	0.4	0.9	1.3	25%	10.2	117%	3.6	13.8	0.4	8.7	58%	9.1
1982	0.9	2.2	3.1	58%	15.0	172%	5.6	20.6	0.8	10.4	70%	11.3
1983	0.7	1.6	2.3	43%	19.7	226%	7.4	27.1	0.8	9.1	61%	9.9
1984	1.4	1.1	2.5	47%	18.8	216%	9.6	28.4	1.6	13.2	89%	14.8
1985	0.6	1.5	2.1	40%	16.7	191%	6.5	23.2	0.2	16.3	109%	16.5
1986	1.3	2.7	4.0	75%	10.7	123%	5.3	16.0	0.8	18.1	121%	18.9
1987	1.3	5.2	6.5	123%	5.8	67%	2.7	8.6	0.3	9.6	64%	10.0
1988	2.1	6.6	8.7	164%	5.2	60%	2.7	8.0	1.3	12.0	81%	13.2
1989	1.1	5.2	6.3	119%	18.0	207%	1.9	20.0	0.4	6.8	46%	7.2
1990	0.6	3.1	3.7	70%	13.9	160%	7.9	21.8	1.3	17.2	115%	18.5
1991	1.0	3.5	4.5	85%	9.6	110%	0.7	10.3	0.9	6.0	40%	6.9
1992	0.1	4.5	4.6	87%	8.4	97%	0.5	9.0	2.2	7.7	52%	9.9
1993	----	----	----		----		----		----	----		----
Goal			5.3		8.7					14.9		

	Hood Canal				Stillaguamish-Snohomish				South Puget Sound			
Year	Hatch	% of Goal	Wild	Total	Hatch	Wild	% of Goal	Total	Hatch	Wild	Total	% of Goal
1981-85	3.8	112%	2.0	5.8	2.0	4.9	67%	6.9	23.3	10.2	33.5	96%
1986-90	6.2	182%	2.0	8.2	1.1	5.2	71%	6.4	33.6	21.6	55.3	158%
1981	3.0	88%	0.3	3.2	3.7	4.0	55%	7.7	26.1	8.6	34.7	99%
1982	5.0	147%	0.4	5.4	2.3	5.2	71%	7.5	19.1	8.8	27.8	80%
1983	2.0	59%	1.8	3.8	1.2	4.9	67%	6.1	21.8	11.3	33.1	95%
1984	4.8	141%	2.5	7.3	1.4	4.1	56%	5.5	27.8	11.9	39.7	114%
1985	4.2	124%	5.2	9.5	1.4	6.3	86%	7.7	22.0	10.3	32.3	93%
1986	4.7	138%	2.8	7.5	0.9	5.8	79%	6.7	23.8	13.2	37.0	106%
1987	6.6	194%	2.3	8.8	1.2	6.0	82%	7.2	29.7	23.3	53.0	152%
1988	10.3	303%	2.9	13.2	1.1	5.2	71%	6.4	26.9	18.6	45.6	131%
1989	6.1	179%	1.4	7.5	1.5	3.9	53%	5.4	47.4	24.9	72.3	207%
1990	3.4	100%	0.7	4.1	1.0	5.1	70%	6.0	40.3	28.1	68.4	196%
1991	5.6	165%	1.8	7.5	0.6	4.4	60%	5.0	22.3	17.3	39.5	113%
1992	1.2	35%	0.9	2.2	1.0	3.5	48%	4.5	18.3	12.8	31.1	89%
1993	----		----	----	----	----		----	----	----	----	
Goal	3.4					7.3					34.9	

Fraser River Escapement
Natural Chinook Indicator Stocks

	Upper Fraser		Middle Fraser		Thompson		Harrison	
Year	Escape.	% of Goal	Escape.	% of Goal	Escape.	% of Goal	Escape.	% of Goal
1975	7,028	29%	15,050	71%	37,035	66%	----	
1976	7,612	31%	10,975	52%	14,875	27%	----	
1977	10,135	41%	13,320	63%	30,321	54%	----	
1978	14,015	57%	13,450	64%	28,465	51%	----	
1979	12,495	51%	8,595	41%	25,145	45%	----	
1980	15,796	65%	9,625	46%	19,330	35%	----	
1981	9,021	37%	8,175	39%	23,375	42%	----	
1982	11,603	47%	10,470	50%	20,385	37%	----	
1983	17,185	70%	15,404	73%	20,381	37%	----	
1984	21,938	90%	13,957	66%	29,972	54%	120,837	50%
1985	34,527	141%	17,595	83%	39,997	72%	174,778	72%
1986	41,207	168%	27,349	129%	45,130	81%	162,596	67%
1987	39,420	161%	27,330	129%	36,730	66%	78,038	32%
1988	34,400	144%	24,164	114%	47,103	85%	35,116	15%
1989	25,310	103%	15,095	71%	37,975	68%	74,685	31%
1990	35,552	145%	25,510	121%	41,704	75%	177,375	73%
1991	27,317	112%	21,170	100%	36,460	65%	90,638	38%
1992	24,330	99%	24,474	116%	39,406	71%	130,310	54%
1993	----		----		----		----	
Goal	24,460		21,130		55,710		241,700	

Southern B.C. Escapement
Natural Chinook Indicator Stocks

	West Coast Vanc. Island		Lower Georgia Strait		Upper Georgia Strait	
Year	Escape.	% of Goal	Escape.	% of Goal	Escape.	% of Goal
1975	1,675	14%	9,525	43%	11,800	231%
1976	1,275	11%	9,240	41%	15,150	297%
1977	3,875	33%	10,655	48%	3,880	76%
1978	6,275	54%	8,035	36%	6,150	121%
1979	3,058	26%	12,400	56%	3,610	71%
1980	6,392	55%	11,530	52%	1,367	27%
1981	5,108	44%	10,420	47%	1,945	38%
1982	7,523	64%	9,520	43%	3,260	64%
1983	3,824	33%	9,080	41%	3,820	75%
1984	5,012	43%	11,150	50%	4,600	90%
1985	4,900	42%	5,010	22%	4,600	90%
1986	4,810	41%	3,038	14%	1,630	32%
1987	3,520	30%	2,630	12%	5,700	112%
1988	5,500	47%	7,040	32%	3,300	65%
1989	8,480	73%	6,830	31%	6,607	130%
1990	5,760	49%	7,635	34%	2,200	43%
1991	5,756	49%	12,895	58%	3,276	64%
1992	7,300	63%	10,893	49%	5,268	103%
1993	----		----		----	
Goal	11,665		22,280		5,100	

Selected Northern B.C. Escapement
Natural Chinook Indicator Stocks

	Nass		Skeena	
Year	Escape.	% of Goal	Escape.	% of Goal
1975	6,025	38%	20,319	49%
1976	5,590	35%	13,078	31%
1977	9,060	57%	29,018	69%
1978	10,190	64%	22,661	54%
1979	8,180	51%	18,488	44%
1980	9,072	57%	23,429	56%
1981	7,950	50%	24,523	59%
1982	6,575	41%	17,092	41%
1983	8,055	51%	23,562	56%
1984	12,620	79%	37,598	90%
1985	8,002	50%	53,599	128%
1986	17,390	109%	59,968	144%
1987	11,431	72%	59,120	142%
1988	10,000	63%	68,705	164%
1989	12,525	79%	57,202	137%
1990	12,123	76%	55,976	134%
1991	4,017	25%	52,753	126%
1992	7,312	46%	63,392	152%
1993	----		----	
Goal	15,890		41,770	

Selected S.E. Alaska and Transboundary Rivers Escapement
Natural Chinook Indicator Stocks

	Blossom		Keta		Taku		Stikine	
		% of		% of		% of		% of
Year	Escape.	Goal	Escape.	Goal	Escape.	Goal	Escape.	Goal
1975	234	18%	325	40%	2,089	16%	1,400	26%
1976	109	9%	134	17%	4,726	36%	800	15%
1977	179	14%	368	46%	5,671	43%	1,600	30%
1978	229	18%	627	78%	3,305	25%	1,264	24%
1979	86	7%	682	85%	4,156	31%	2,332	44%
1980	142	11%	307	38%	7,544	57%	4,274	81%
1981	254	20%	526	66%	9,786	74%	6,668	126%
1982	552	43%	1,206	151%	4,813	36%	5,660	107%
1983	942	74%	1,315	164%	2,062	16%	1,188	22%
1984	813	64%	976	122%	3,909	30%	2,588	49%
1985	1,134	89%	998	125%	7,208	55%	3,114	59%
1986	2,045	160%	1,104	138%	7,520	57%	2,891	55%
1987	2,158	169%	1,229	154%	5,743	44%	4,783	90%
1988	614	48%	920	115%	8,626	65%	7,292	138%
1989	550	43%	1,848	231%	9,480	72%	4,715	89%
1990	411	32%	970	121%	12,249	93%	4,392	83%
1991	382	30%	435	54%	10,153	77%	4,506	85%
1992	240	19%	347	43%	11,058	84%	6,627	125%
1993	----		----		----		----	
Goal	1,280		800		13,200		5,300	

CERTIFICATE OF SERVICE

I am a citizen of the United States and a resident of the State of Oregon. I am over 18 years of age and not a party to this action. My business address is P.O. Box 86620, Portland, OR 97286

I certify that on December 11, 2025, the foregoing DECLARATION OF DR. DARRYLL OLSEN IN SUPPORT OF INTERVENOR-DEFENDANT COLUMBIA-SNAKE RIVER IRRIGATORS ASSOCIATION RESPONSE TO PLAINTIFFS' MOTIONS FOR PRELIMINARY INJUNCTION will be electronically mailed to all parties enrolled to receive such notice.

s/ Carole A. Caldwell