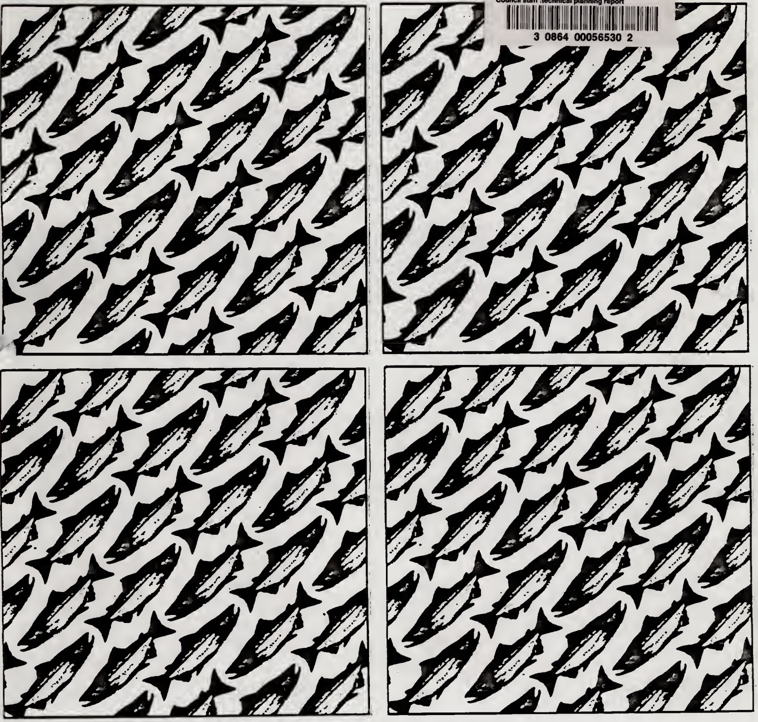
Council Staff:
TECHNICAL PLANNING REPORT



NORTHWEST POWER PLANNING COUNCIL

October 22, 1986

COUNCIL STAFF: TECHNICAL PLANNING REPORT

(October 1986)

Contents

INTRODUCTION

This document accompanies the Council staff issue paper on Salmon and Steelhead System Objective and Policies. As described in the Draft Amendment Document, Sections 203 and 204 (Northwest Power Planning Council, 1986b), the Council staff sees subbasin planning as the next logical step in implementing a system objective and policies. Many tools, such as existing data bases and plans, already are available for use in subbasin planning. The Council staff has compiled the information contained in this document to provide a basis from which to advance the discussions already initiated for subbasin planning. This document includes information that can be used to link the system policies to subbasin plans and is provided at this time to show this link. Comments and questions should be addressed to the Council staff at the central office by December 15, 1986.

This document includes estimates of production for the Columbia River Basin using the Council's data base and other sources. It also includes four tools to aid subbasin planning as outlined above. These are: 1) an overview of subbasin planning, 2) a preliminary analysis of production using the Council's planning model, 3) a list of mainstem passage survival parameters and assumptions, and 4) an outline for genetics risk analyses.

An analysis of production estimates for the basin is presented first. This analysis uses the Council's natural production data base, currently in a preliminary stage of development and under review for accuracy, as well as other sources. The analysis here provides estimates cited in the System Objective and Policies Issue Paper and also demonstrates the utility of the data base for use in planning. In addition, it provides a demonstration of the effect of some of the hypotheses resulting from the model analysis.

An overview of subbasin planning also is presented. This overview suggests a process by which system and subbasin planning may be integrated. It also proposes means for coordinating this process.

The model analysis demonstrates the current capability of the Council's model as a planning aid for system and subbasin analysis. The analysis here demonstrates, in a preliminary fashion, how subbasin and system factors interact to affect natural productivity, and shows how the model might be used to provide information for decision makers.

A list of mainstem passage parameters and assumptions, for potential use in the subbasin planning process, also is included. The list of passage parameters and assumptions is consistent with the Council's current policies related to mainstem passage, as described in the System Objective and Policies Issue Paper and in the Draft Amendment Document. Passage parameters and assumptions listed for the eight federal lower Snake and Columbia river hydroelectric projects were identified in 1985-86 by the Council's Mainstem Passage Advisory Committee. The parameters and assumptions listed for the five mid-Columbia public utility district projects were identified in study findings submitted to the Federal Energy Regulatory Commission by the Mid-Columbia Coordinating Committee, unless otherwise noted.

Finally, an outline for a genetic risk analysis is provided in this document. It is intended to further recognition of the importance of salmon and steelhead gene pools and the sense that genetic resources must be managed, not simply ignored because they are difficult or impossible to measure. The System Objective and Policies Issue Paper states that genetic risk is an important consideration in production planning.

I. PRODUCTION ESTIMATES

In the System Objective and Policies Issue Paper, an interim objective of doubling current run sizes is proposed. This analysis of production provides an estimate of how much increased production may be feasible, based on the Council's current Columbia River Basin Fish and Wildlife Program (Program; Northwest Power Planning Council 1984), the Draft Amendment Document, other firmly planned production, and natural production potential. These production estimates are provided to help assess whether an interim objective of doubling current runs is reasonable.

A. PROGRAM CAPABILITY

1. Natural and Wild Production

An estimate of the current capability of the program to increase the wild and natural adult run size was calculated using the estimates of increases from habitat and tributary passage improvement measures provided by the fish and wildlife agencies, tribes and others when they proposed the projects to the Council for inclusion in the program. In general, estimates are available for most of the habitat and tributary passage improvement measures currently included in sections 704 and 904 of the program.[1] These estimates covered about 50 percent of such projects currently in section 704 of the program and predicted an increase of about 200,000 adult fish. Since this estimate only accounted for 50 percent of the habitat and tributary passage measures, it was assumed that the other 50 percent of these measures could produce from one-half to an equal number of fish, hence a total range estimate of 300,000 to 400,000 adults. In addition, habitat and passage improvements in the Yakima basin program (section 904) could result in an additional 100,000 adult production there (United States Bureau of Reclamation - Washington Department of Ecology 1985). Overall adult production is then estimated as 400,000 to 500,000 adult fish.

2. Hatchery Production

To estimate the increased hatchery production from the existing program the following assumptions were used:

a) Expansion and/or improvements of existing hatcheries to reach full production potential could result in increases of adult returns of 112,000 to 300,000 adult fish, depending on the rearing densities utilized. The lower figure assumes a rearing density of 0.3 pounds per cubic foot of rearing capacity, while the higher figure is based on a 0.8 pounds per cubic foot density factor.[2]

b) The current planning estimates for the Yakima Outplanting Facility (section 704(i)(3)) estimate that, within 10 years after completion, the proposed Yakima basin facilities could produce an adult return of approximately 43,000 and the proposed Klickitat

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1/ Habitat and tributary passage improvement measures are included in program measures 704(d)(1), 904(b) and 904(d).

2/ Estimates here are based on Bouck 1986 and GAIA 1985. The Bouck estimates are preliminary and under review. They assume increases in rearing volumes and densities, and appear to rely considerably on improving production at lower river hatcheries. The GAIA estimates also are undergoing review.

facilities could produce an adult return of 33,000 for a total of 76,000 returning adults (Scribner 1986).[3]

c) The Umatilla steelhead facility is planned to produce approximately 200,000 steelhead smolts with an estimated adult return of approximately 5,000 adult fish.

Summing the totals from a, b, and c above results in a range of 193,000 to 381,000 adult fish that could be produced from the existing program hatchery measures.

In addition to these measures currently in the program, the Draft Amendment Document (Section 704 (i)(5)) proposes development of a northeast Oregon spring chinook hatchery. This hatchery would produce 2.4 to 3.0 million smolts. Applying a 1 percent survival factor to these numbers provides an estimate of 24,000 to 30,000 returning adults. The addition of these numbers provides a total hatchery estimate of 217,000 to 441,000 adult fish.

3. Passage Improvements

It is estimated that mainstem passage measures in the current program could increase current run sizes by an estimated 48,690 to 57,330 adult fish. This is based on increasing mainstem system survival by about 3 percent over the current level, for existing production above Bonneville Dam (1.0 million adult fish) as well as for the estimated increases from hatcheries (223,000 to 411,000 adult fish) and habitat and tributary passage improvements (400,000 to 500,000 adult fish). (See Section II. C. of this document.)

4. Total Existing and Proposed Program Capability

The total program capability (sum of 1., 2., and 3. above) is estimated to range from 665,690 to 968,330 adult fish.

B. OTHER FIRMLY PLANNED RATEPAYER-FUNDED PRODUCTION

Completion of the remaining Lower Snake River Compensation Plan hatcheries (Clearwater and Magic Valley) and bringing the existing Compensation Plan hatcheries to full production could increase runs by an estimated 45,000 to 50,000 adult fish. These estimates are based on planned rearing capacities provided by the Corps of Engineers (1985).

C. SUMMARY OF PLANNED PRODUCTION

The estimate of total currently planned production is derived by summing all of the above estimates. This provides a total adult production range estimate of 710,690 to 1,018,330 adult fish.

D. NATURAL PRODUCTION CAPABILITY BEYOND THE PROGRAM

There is additional natural production capability in the Columbia River Basin beyond that accounted for in the current program (estimated in Section I. A. 1. above). Estimates of natural production potential involve much uncertainty, as exemplified in the model analysis described in part II. B.

3/ The Council has not yet approved the master plan for these facilities, as required before Bonneville implementation. See program section 704(i)(3).

Estimates of the total existing and potential natural/wild production in the Columbia River Basin were calculated in several different ways using the Council's Anadromous Fish Data Base and information on existing run sizes taken from the Council staff's Compilation of Information on Salmon and Steelhead Losses in the Columbia River Basin (Northwest Power Planning Council 1986a). To calculate the potential and existing adult run size, a computer program was developed that relied upon the existing and potential smolt density production estimates (smolts/square foot of habitat) for 27 subbasins and six stocks within the Columbia River Basin. The smolt density estimates were developed for the Council by Envirosphere Company (Envirosphere 1986). These density estimates were based on currently utilized habitat and do not consider areas above permanent blockages. For a listing of the smolt density estimates used, see Attachment 1.

The following algorithm was used to calculate estimated existing and potential adult returns to the spawning ground:

Smolts/square foot
X
Area of subbasin occupied by a given stock
X
Downstream project survival raised to the power of the number of dams below the subbasin
X
Ocean survival
X
Upstream project survival raised to the power of the number of dams below the subbasin[4]

To calculate the area of a subbasin occupied by a given stock only, those stream orders used for spawning by the stock in question were considered. Table 1 shows which stream orders (the mainstem Columbia and Snake rivers are first order streams) were used for each stock.

TABLE 1
ORDERS OF STREAMS FOR ESTIMATING AREA OCCUPIED BY A STOCK

Stock	Stream Order
Spring chinook	Third order and above
Fall chinook	Second order only
Summer chinook	Second order only for Columbia River; third order and above for Snake River
Coho	Third order and above
Summer steelhead	Third order and above
Winter Steelhead	Third order and above

4/ See Attachment 2 for an example of the computer output.

Adult spawning estimates were converted to run size using the ratio of ocean catch to inriver catch as described in the Compilation of Losses.[5]

As a cross-check on the accuracy of the existing natural run size estimate, a second calculation was performed using the data on current run sizes by stock presented in the Compilation of Losses. In this case, the run size estimates were multiplied by the percent of each stock estimated to be of natural origin, with the exception of fall chinook for which numbers were already available. Table 2 shows the assumptions used for these calculations and the results of the calculations follow.

TABLE 2
PERCENTAGES OF STOCKS ASSUMED TO BE OF NATURAL ORIGIN

STOCK	PERCENT HATCHERY	PERCENT NATURAL/WILD
Spring chinook	80	20
Summer chinook	90	10
Coho	90	10
Summer steelhead	80	20
Winter steelhead	80	20

The results of the density-based potential and existing run size estimates are presented in Tables 3 and 4. The results show a total existing naturally-produced run size of approximately 650,000 adult salmon and steelhead, compared to an estimate of about 700,000 adults using the percent natural/ wild estimates referenced in Table 2. The potential naturally-produced run is estimated to be 1.75 million adult salmon and steelhead. Subtracting the existing run estimates from the potential estimate provides a run size range of 1 to 1.1 million additional salmon and steelhead that can be naturally produced within the Columbia River Basin.

E. ARTIFICIAL PRODUCTION CAPABILITY

Activities to estimate the artificial production capability in the Columbia River Basin are in progress. Program Section 704(f)(1) calls on Bonneville to fund a survey of existing and potential sites for hatcheries. This survey is being completed (potential sites are being added) and reviewed. Program Section 704(j)(1) calls on Bonneville to fund development and testing of low-capital propagation facilities. Action Item 34.16 in the Draft Amendment Document would call on Bonneville to coordinate these studies by July 1987.

5/ Council Staff Compilation of Information on Salmon and Steelhead Losses in the Columbia River Basin at page 16 (data). Draft Amendment Document, in Technical Appendix 2.

TABLE 3. EXISTING NATURAL RUN[1]

		Fall Chinook Run Existing	Spring Chinook Run Existing	Summer Chinook Run Existing	Coho Run Existing	Summer Steelhead Run Existing	Winter Steelhead Run Existing	Total Existing Run
1.	Clackamas	8,082	1,503	0	28,671	3,014	3,263	11,534
2.	Clearwater	0	4,815	0	0	4,055	0	8,870
3.	Cowlitz	63,206	774	0	3,879	0	1,495	69,354
4.	Deschutes	52,364	444	0	0	1,987	0	54,795
5.	Entiat	0	80	123	0	102	0	305
6.	Grande Ronde	0	2,486	0	159	2,346	0	4,991
7.	Grays	1,196	0	0	861	0	348	2,405
8.	Hanford Reach	279,598	0	0	0	0	0	279,598
9.	Hood	0	0	0	219	326	1,012	1,557
10.	Imnaha	0	557	0	0	658	0	1,215
11.	John Day	840	1,102	0	0	2,424	0	4,366
12.	Kalama	0	525	0	0	0	0	610
13.	Klickitat	0	913	0	0	184	0	1,097
14.	Lewis	10,648	522	0	1,476	0	702	13,348
15.	Methow	0	112	501	0	86	0	699
16.	Okanogan	0	3	871	0	0	0	874
17.	Salmon	0	7,384	3,427	0	4,856	0	15,667
18.	Sandy	8,008	312	0	1,038	0	756	10,114
19.	Lower Snake	0	103	0	0	311	0	414
20.	Tucannon	0	367	0	0	515	0	882
21.	Umatilla	0	0	0	0	709	0	709
22.	Walla Walla	0	0	0	0	629	0	629
23.	Washougal	0	0	0	444	0	250	694
24.	Wenatchee	0	339	910	0	396	0	1,646
25.	Willamette	36,863	5,505	0	9,510	1,504	4,585	57,967
26.	Wind/White Salmon	0	115	0	0	552	38	705
27.	Yakima	27,574	1,970	0	0	694	0	30,238
	TOTAL	488,382	29,939	5,834	46,257	25,348	12,534	608,295[2]

[1]Data compiled from Northwest Power Planning Council's Anadromous Fish Data Base.

[2]No density estimates were made for sockeye, but the Compilation of Information on Salmon and Steelhead Losses shows an estimated run size of 58,200 adults.

TABLE 4. EXISTING POTENTIAL RUN[1]

		Fall Chinook Run Potential	Spring Chinook Run Potential	Summer Chinook Run Potential	Coho Run Potential	Summer Steelhead Run Potential	Winter Steelhead Run Potential	Total Potential Run
1.	Clackamas	29,554	25,630	0	32,460	5,775	5,816	100,235
2.	Clearwater	0	17,263	0	0	4,902	0	22,165
3.	Cowlitz	168,493	0	0	28,056	0	3,198	199,747
4.	Deschutes	145,917	7,048	0	0	2,340	0	155,306
5.	Entiat	0	0	1,808	0	92	0	1,900
6.	Grande Ronde	0	12,412	0	2,307	2,569	0	17,288
7.	Grays	4,382	0	0	6,237	0	640	11,259
8.	Hanford Reach	286,000	0	0	0	0	0	286,000
9.	Hood	0	0	0	3,177	564	1,221	4,962
10.	Imnaha	0	2,777	0	0	779	0	3,556
11.	John Day	93,812	18,005	0	0	2,458	0	114,276
12.	Kalama	0	0	0	0	0	188	188
13.	Klickitat	0	15,450	0	0	166	0	15,616
14.	Lewis	41,654	3,823	0	10,686	0	1,222	57,386
15.	Methow	0	1,621	7,383	0	184	0	9,188
16.	Okanogan	0	51	12,799	0	0	0	12,851
17.	Salmon	0	17,792	17,089	0	5,501	0	40,383
18.	Sandy	56,262	5,262	0	7,512	0	1,204	70,241
19.	Lower Snake	0	518	0	0	280	0	798
20.	Tucannon	0	1,830	0	0	339	0	2,169
21.	Umatilla	0	0	0	0	638	0	636
22.	Walla Walla	0	0	0	0	754	0	754
23.	Washougal	0	0	0	3,219	0	440	3,655
24.	Wenatchee	0	4,975	13,376	0	642	0	18,993
25.	Willamette	245,454	93,407	0	164,763	2,773	11,545	517,942
26.	Wind/White Salmon	0	2,273	0	0	497	78	2,848
27.	Yakima	46,244	37,843	0	0	2,962	0	87,049
	TOTAL	1,117,776	267,988	52,456	258,417	24,2156	26,552	1,757,405[2]

[1] Data compiled from Northwest Power Planning Council's Anadromous Fish Data Base.

[2] No density estimates were made for sockeye, but the Compilation of Information on Salmon and Steelhead Losses shows an estimated run size of 58,200 adults.

II. TOOLS FOR SUBBASIN PLANNING

A. AN OVERVIEW OF SUBBASIN PLANNING

Figures 1 and 2 illustrate the concepts and relationships which the Council staff believes may underlie Columbia River Basin salmon and steelhead system and subbasin planning. Figure 1 represents the interrelationship of the three elements (passage, harvest, production) of system planning with a triangle. The Salmon and Steelhead System Objective and Policies Issue Paper discusses these elements and describes alternatives for the production corner of the triangle. The issue paper also proposes annual and five-year review cycles for evaluation of passage, harvest, and production actions.

Major elements of subbasin planning are proposed in the Draft Amendment Document, section 204. This overview proposes a process by which subbasin planning could proceed. The United States v. Oregon (1986) parties also may identify subbasin planning as an important, particularly with respect to allocating tributary harvest. The Council staff anticipates that concepts of subbasin planning will become more developed and refined, as a result of discussions of system objectives and policies, the Draft Amendment Document, this compilation of subbasin planning tools, and the United States v. Oregon discussion.

Subbasin planning could occur as outlined in Figure 2. In this process, each subbasin is analyzed to determine what, if any, production strategies will succeed in meeting subbasin production goals. This analysis is aided by the system model (see part II.B.) and incorporates passage objectives (see part II.C.), mixed-stock harvest, and terminal harvest objectives and policies set by the fishery managers. The production strategy selected for any particular subbasin should reflect what is possible and desirable, given the system policies for passage, harvest and production. The sum of all subbasin production should reflect and be consistent with the system production objectives and policies.

An important question in subbasin planning is how to allocate a basinwide objective, such as doubling the current run size, among subbasins. A possible starting point for dividing the increased production necessary to double the basinwide run size would be to allocate one-third of this increase to each of three areas above Bonneville Dam (i.e., subbasins between Bonneville and McNary dams, mid-Columbia River subbasins, and Snake River subbasins). Then plans for subbasins within each area could address how each would contribute to the area objective.

FIGURE 1: SYSTEM PLANNING

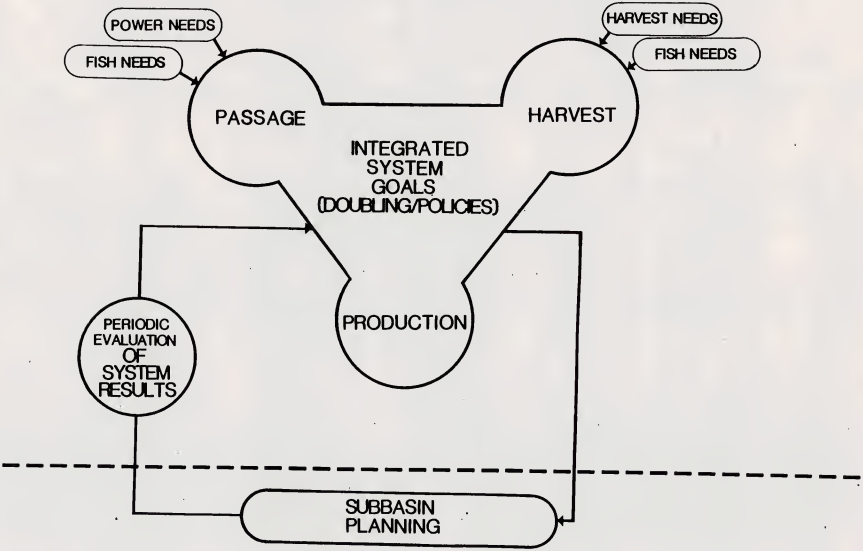
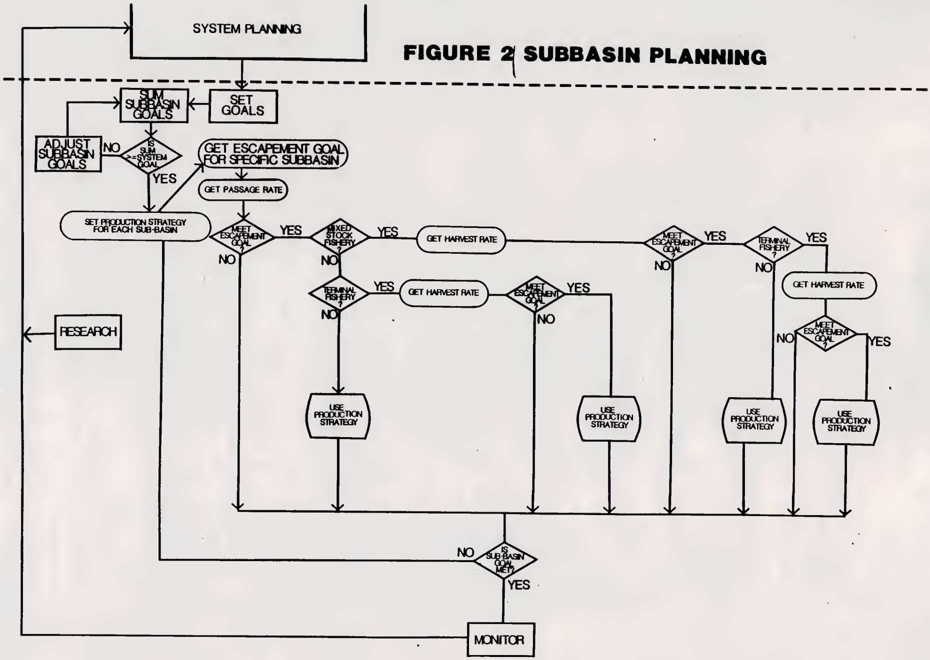


FIGURE 2 SUBBASIN PLANNING



Subbasin planning could be coordinated by a management group composed of representatives of the fishery agencies, Indian tribes, and others (such as land and water managers). (Utility interests such as Bonneville, the Pacific Northwest Utilities Conference Committee, and others also could be involved in a review capacity.) The management group could include the following subgroups:

1. Subbasin group. This group (supported by teams for individual subbasins) would oversee development of preliminary subbasin production strategies. It then would propose escapement goals needed to implement the preliminary production strategies, and submit these escapement goals to the system integration group. The subbasin group would prepare genetic risk analyses also to be submitted to the system integration group. The subbasin group also would develop tributary harvest allocations within subbasins.

2. System integration group. This group would review the proposed escapement goals submitted by the subbasin group, to determine whether the goals can be met given system harvest and passage constraints, whether there are conflicts among escapement goals for different subbasins, and whether the preliminary subbasin production strategies would produce sufficient fish to meet basinwide (or areawide) targets. The system integration group and the subbasin production group would work together until mutually satisfactory escapement goals could be developed.

The management group proposed here would be similar to that proposed in the Draft Amendment Document (Section 204), in which a planning work group, including a management subgroup (fishery agencies and Indian tribes) and review subgroup (land and water manager, utilities, and others), are proposed. Here the management group is further divided into subbasin and system integration groups. The only substantive difference between the two proposals is that here it is proposed that land and water managers be part of the management group rather than the review group.

Some United States v. Oregon parties have proposed establishment of a Production Advisory Committee, to coordinate information, review and analyze existing and future artificial and natural production programs pertinent to the agreement, and submit recommendations to management entities. The subbasin and system integration groups should be closely aligned with this Production Advisory Committee, when formed.

B. A MODEL-BASED ANALYSIS OF FACTORS AFFECTING NATURAL PRODUCTION OF SPRING CHINOOK IN THE COLUMBIA BASIN

As a contribution to the planning of salmon and steelhead production in the Columbia basin, the Council staff, along with the Modeling Work Group,[6] has performed an analysis of factors affecting natural productivity of spring chinook in selected subbasins. This exercise was intended to provide insight into natural production processes, and investigate the results of uncertainty in our knowledge on the projected outcome of production measures. In addition, the intent was to experiment with ways modeling might be used to assist in the planning of salmon and steelhead production in the Columbia basin.

This section summarizes the methods, data, and results of the analysis to date. Not all important variables affecting production on a subbasin or system basis have been examined. In particular, the effect of harvest pattern and rate on the productivity of the subbasins was beyond the scope of this analysis. A

6/ The Council's Modeling Work Group includes Ted Bjornn, University of Idaho; Lars Mobrand, consultant; Phil Roger, Columbia River Intertribal Fish Commission; Ron Boyce, Oregon Department of Fish and Wildlife; and Chip McConnaha, Council Staff.

complete account of the methods and data used in the present analysis is included here as reference for future work.

The results of the analysis indicate that existing uncertainty in some key parameters, such as natural survival rate and carrying capacity, may produce considerable uncertainty in the projections of management actions designed to increase fish production. In the simulations, the importance of natural survival rates and carrying capacity in determining the natual production of spring chinook differed among subbasins depending on the survival rate of juvenile fish at mainstem hydroelectric projects. Natural production of spring chinook in the Methow River, which was simulated with rather poor passage survival, was limited by the passage survival rate. In the Grande Ronde and Yakima rivers, production was limited by natural survival rates and the carrying capacity. These basins were simulated with relatively high passage survival rates.

1. Procedures

a. Study Design.

The analysis used the Council's Production Planning Model[7] to simulate the production cycle of spring chinook. The model simulates the salmonid life cycle from initial egg deposition to return as spawning adults. The fish production in a subbasin is simulated and passed through a set of generic variables that affect survival outside the subbasin. An important feature is the use of a Beverton-Holt type relationship to determine the fry-to-smolt survival rate as a function of fry abundance. The model provides the ability to manipulate subbasin-specific data such as juvenile survival rates, carrying capacity, initial escapement and fecundity, as well as factors external to the subbasin such as survival rates at hydroelectric projects, natural survival rates, and harvest rates.

The variables studied in this analysis are shown in Table 5. Because of time and data constraints, the analysis was limited to the natural production of spring chinook. However, many of the key parameters used in the analysis are common to most anadromous salmonids in the basin. The general types of response, if not the magnitude, should apply to other species as well.

TABLE 5
VARIABLES EXAMINED FOR SPRING CHINOOK

Subbasins	Subbasin Parameters	Generic Parameters
Methow	Egg-Smolt Survival	Average Project Survival
Grande Ronde	Terminal Harvest	System Passage Survival
Yakima	Carrying Capacity	Early Marine/Ocean Survival

7/ A description of the model and a discussion of the major assumptions was provided in a technical discussion paper: Columbia River Basin Fishery Planning Model, N.W. Power Planning Council, June 1986.

The three subbasins were chosen to represent the three major areas of the Columbia basin (Figure 3). The Methow River is located at the top of the mid-Columbia region above nine hydroelectric projects. The first five of these projects (Wells, Rocky Reach, Rock Island, Wanapum, and Priest Rapids) are owned and operated by nonfederal public utilities. Although these five projects have little or no juvenile passage facilities, an annual spill program occurs to pass juvenile migrants in accord with a stipulation from the Federal Energy Regulatory Commission. The four projects on the lower Columbia River (McNary, John Day, The Dalles, and Bonneville) are federal projects operated by the U.S. Army Corps of Engineers. The McNary project has an extensive facility for collecting and bypassing juvenile fish prior to their entry into the turbines. Approximately 20 percent of the juvenile spring chinook collected by this facility are placed in barges or trucks and transported to below Bonneville Dam. Similar bypass facilities exist at John Day Dam, but all fish collected are bypassed back to the river. The Dalles Dam has a sluiceway bypass system, while both powerhouses at Bonneville Dam contain bypass facilities.

The Grande Ronde River is a tributary to the Snake River, and is above eight hydroelectric projects. The first four dams are located on the Snake River (Lower Granite, Little Goose, Lower Monumental, and Ice Harbor dams). The four projects below the mouth of the Snake River are the same as the lower four projects described above for the Methow River. Lower Granite and Little Goose dams contain collection and bypass facilities similar to those of McNary Dam; Lower Monumental Dam does not have a turbine intake screening and bypass system, while a sluiceway at Ice Harbor Dam is used to bypass juvenile migrants. All of the fish collected by the Lower Granite facility and about 20 percent of the spring chinook collected by the Little Goose facility are transported to below Bonneville. Although fish from the Methow and the Grande Ronde rivers must pass a similar number of dams, the migration conditions are markedly different, particularly with respect to the proportion transported.

The Yakima River was chosen to represent the lower Columbia region. Fish from the Yakima pass the four lower Columbia River federal projects described above (McNary, John Day, The Dalles, and Bonneville).

The subbasins chosen also represent important differences in production capacity. The United States v. Oregon estimates of smolt carrying capacity of spring chinook in the Grande Ronde and Methow rivers were virtually the same: 450,000 and 440,000 respectively. The estimated smolt carrying capacity for the Yakima, in contrast, was 1,670,000 spring chinook (Roger and Boyce, personal communication).

Parameters in the model that are unique to the subbasins and the generic parameters (those external or common to the subbasins) were chosen to represent key factors in each major life history stage, as well as areas of probable management action. The latter include actions within the subbasins such as improvement and increase in habitat, while mainstem passage survival rate represents a management action outside the subbasin. Ranges used for these parameters and their derivation are explained below.

In the analysis, the subbasin and generic parameters in Table 5 were varied over a range and the effect on model output was observed. Because of the large number of permutations that would result from simulating all combinations of the parameters over their range, similar variables were paired for analysis. Each parameter within a pair was examined individually. A number of simulations were made, each time varying the target parameter, while all other variables were held constant (Table 6). To focus on the effect of the target variables on model output, all sources of random variation in the model were turned off.

FIGURE 3

MAP OF SUBBASINS USED IN MODELING ANALYSIS

METHOW RIVER SUB-BASIN

YAKIMA RIVER SUB-BASIN

GRANDE RONDE RIVER SUB-BASIN

Source: Northwest Power Planning Council Fish & Wildlife Program

TABLE 6
SIMULATIONS SCENARIOS

Scenario	Variables	Constants
A	Egg-Smolt Survival Early Marine Survival	Carrying Capacity Passage Survival
B	Carrying Capacity Passage Survival	Egg-Smolt Survival Early Marine/Ocean Survival

In Scenario A, the natural survival factors were balanced to result in a given level of productivity as measured by the recruit/spawner ratio (explained below). These factors are, for the most part, not subject to management action. Management action can affect the parameters in Scenario B. Smolt carrying capacity places an upper limit on the number of smolts that can be produced by a subbasin. It can be affected by increasing the available habitat by removing blockages, for example. Passage survival rate is determined by a suite of actions involving the amount of water released to augment flows, the levels of spill provided, and presence and operation of bypass facilities.

The range of the target parameter simulated two situations: first the uncertainty in knowledge of the value for the parameter, and second, the effect of management actions that might result from change in the parameter. In terms of the analysis, these two situations are identical; observing the effect of a range of uncertainty on model output is procedurally no different than observing the effect of a range of management options. This procedural similarity also extends to the effect of the range which is measured as the slope of the response. The consequences of uncertainty or change in parameters that produce a curvilinear response will vary depending on whether the value is in a region of relatively flat response or one of rapid change. Linear variables, however, produce uniform change throughout a range and so have a predictable type of effect, although the exact value of the response may be uncertain. These differences in type of response can affect the risk involved in management actions, and the importance of parameters to monitoring or research efforts.

b. Input Data.

Input data for the model is placed in three files: BASFILES contain information specific to the subbasin, GENFILES contain generic data, mainly for those variables affecting survival outside the subbasins, and FLOFILES contain a 50-year record of flows at The Dalles Dam. The latter is used by the model to provide annual variation in the mortality rate occurring in the reservoirs as a function of flow. Because all sources of random variation in the model were turned off, including variation in reservoir mortality, the FLOFILE was not important to this investigation.

Almost all parameters used as input to the model have a high degree of uncertainty. Indeed, one of the aims of this study was to examine how this uncertainty in key variables affected the model behavior. For data other than the target variables in Table 5, the intent was to use data representing a consensus among fishery managers and researchers to the extent possible. Even with a consensus, considerable uncertainty is present in most of the estimates. The best collection of consensus data regarding production in the basin was compiled by participants in the United States v. Oregon proceedings. This data is used whenever applicable. A second major source of data was the compilation by Howell et al. (1985). Other data were not available for some subbasins from any source, in which case the data was extrapolated from other basins or calculated from various sources. Printouts of the BASFILES and GENFILES used in this analysis and an explanation of data sources are provided in Attachment 3.

The parameters listed as variables in Scenario A of Table 6 represent a balancing of natural survival rates. Despite their importance in determining the productivity of subbasins, very little is known regarding the value of these parameters. For this analysis, the best available estimates of the natural survival rates were used. To simulate the probable uncertainty in the estimates, an arbitrary range was set around these estimates. These ranges represent judgements regarding plausible ranges of uncertainty, as well as likely ranges resulting from management actions.

Although the value of these survival rates, particularly the adult survival rates, may be uncertain, it is possible to estimate the overall ratio between the number of spawners and the resulting number of recruits to fisheries and spawning escapement under relatively pristine conditions. This ratio provides a target for assigning combinations of juvenile and adult survival rates for use in the simulations.

Bjornn (personal communication) has estimated the recruit/spawner ratio for upriver spring chinook during the period 1939 to 1954 when relatively few dams were present. His analysis utilized fish counts at Bonneville Dam plus estimates of lower river harvest to estimate the number of recruits produced. This assumes that the ocean harvest of spring chinook was small relative to the population size. The parent spawners of these recruits were estimated by taking the Bonneville Dam count four year earlier and adjusting it for known harvest and assumed natural losses between the dams and the spawning grounds. Using the assumption that the parent-recruit relation for upriver spring chinook fit the Beverton-Holt model, two parameters were estimated. These are the survival rate to recruit at very low (theoretically one) spawner density and the maximum number of adult recruits produced. The survival rate needed is equivalent to the slope of the curve near the origin. While a variety of curves could be fitted to the available data (Figure 4), it was felt that a curve with the slope near the origin equal to 24 and recruit carrying capacity of 350,000 provided the most reasonable representation of the recruit/spawner relation fo r upriver spring chinook. This is for a period when relatively few dams were present, and the quality of spawning and rearing habitat was degraded in some tributaries, but nearly pristine in others.

To provide a target for determining the natural survival rates, it was assumed that a 24:1 recruit/spawner ratio was appropriate. Because the statistical confidence of this estimate was unknown, and the uncertainty was assumed to be great, a range was established around the point estimate from 16 to 32 recruits per spawner at very low densities. Various combinations of egg-smolt, early ocean, and adult survival rates were used in the analysis to result in recruit/ spawner ratios within this range. Ranges of survival rates were based on "most probable" point estimates from the literature.

The value of the juvenile (egg-smolt) survival rate is particularly important in the model because of its role in determining the shape of the Beverton-Holt function. In the model, the shape of this function is determined by the maximum fry-smolt survival rate at very low (theoretically one) fry densities, and the smolt carrying capacity in a manner similar to that described above for the recruit/ spawner relationship. Because this function is the major non-linear relationship in the model, the recruit/ spawner relationship in the model also follows the Beverton-Holt function.[8]

In contrast to the early ocean and adult survival rates, the juvenile (egg-smolt) survival rate has been investigated in the Columbia Basin. Although all of these studies have been done at juvenile densities higher than that required by the Beverton-Holt function, extrapolation of these values should provide an estimate of the required parameter. Boyce (personal communication) has performed such an analysis

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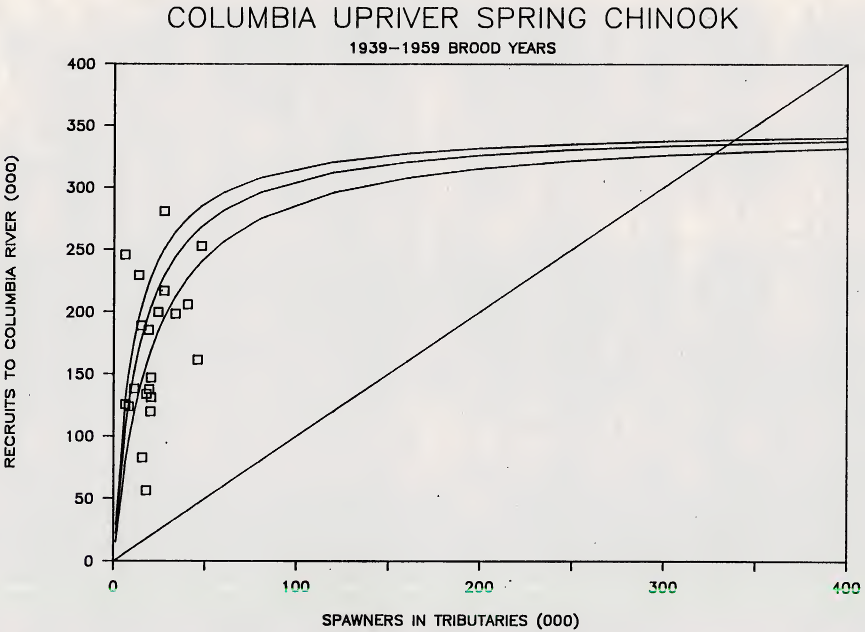
8/ A curvilinear response is also seen in the model as the result of the survival rate at the mainstem hydroelectric projects. Passage survival rate (adult and juvenile) acts as a power function based on the number of dams.

FIGURE 4


COLUMBIA UPRIVER SPRING CHINOOK
1939-1959 BROOD YEARS
RECRUITS TO COLUMBIA RIVER (000)
400
350
300
250
200
150
100
50
0
0
100
200
300
400
SPAWNERS IN TRIBUTARIES (000)

using estimates of egg-smolt survival rate from the Deschutes River (Jonasson and Lindsay, 1983), the John Day River (Knox et al., 1984). the Yakima River (Major and Mighell, 1969), and the Lemhi River (Bjornn, 1978). The estimates from these studies are plotted against the percent seeding level in Figure 5. Percent seeding is the egg deposition of each brood during the studies as a percent of the maximum egg capacity (determined from the maximum in-river catch and escapement). The regression line through these points was highly significant ($r = 0.766$, $p < 0.01$) using the natural log of the seeding level. The Y intercept of this line yields an estimate of the survival rate at very low densities of 22 percent.

Estimates of the early ocean (estuarine) and adult ocean survival rate are essentially nonexistent. However, if the egg-smolt survival provided by Boyce and the recruit/ spawner ratio from Bjornn are accepted as most probable estimates, the smolt to adult survival rate, the product of the two unknown survival rates, must be around 5.0 percent.[9] This is within the range of 3.1 to 13.5 percent smolt-to-adult survival reported by Ebel et al. (1979). Because in the model the estuarine and adult ocean survival rates are used as simple linear functions, the exact value of each is not as important as the product. A value for adult ocean survival of 50 percent was fixed in the analysis. This value is similar to values used for ocean harvest modeling in the Pacific Salmon Treaty negotiations between the United States and Canada (Roger, personal communication). To obtain a range of smolt to adult survival rates, the estuarine survival rate was varied over a range to result in a smolt to adult survival rate of 3 to 15 percent, approximating the range estimated by Ebel et al. (1979).

For scenario B (Table 6) the natural survival rates were fixed at the most probable point estimates. These are: egg-smolt survival 22 percent, estuarine survival 10 percent, and adult ocean survival 50 percent. This results in a recruit/spawner ratio of 24:1 assuming 2,200 eggs per spawner.

The use of these survival rates makes the assumption that one set of values is appropriate for all three subbasins. Differences in productivity among subbasins (smolts out of the subbasin) are assumed to be largely the result of differing smolt carrying capacities.[10] This in part was the result of a lack of data from the Methow and Grande Ronde rivers. There is some basis, however, to suppose that low density juvenile survival rates do not vary markedly between subbasins. For instance, the data points provided in Figure 5 from four different subbasins show a surprisingly good fit to a common function. Lacking data, there is also no reason to think that survival rates after entry into the mainstem Columbia vary between subbasins.

Smolt carrying capacity was estimated by the United States v. Oregon participants (Roger and Boyce, personal communication). In Scenario A (Table 6) carrying capacity was assumed to be equal to the point estimates. To provide a range of uncertainty and to simulate changes in carrying capacity for Scenario B, the United Statese v. Oregon estimates were arbitrarily varied from 0.75 to 2.0 times the point estimates.

Survival rates of smolts passing the mainstem hydroelectric projects were based on information compiled by the the Council's Mainstem Passage Advisory Committee (MPAC). In Scenario A, the passage conditions simulated present conditions using MPAC values when appropriate. A transportation benefit ratio of approximately 2:1 was judged to be appropriate for spring chinook transported from Lower Granite Dam under average flow conditions. This is simulated in the model by applying an 80 percent survival to transported fish. Values for the other passage parameters can be found in the listing of GENFILE2 in

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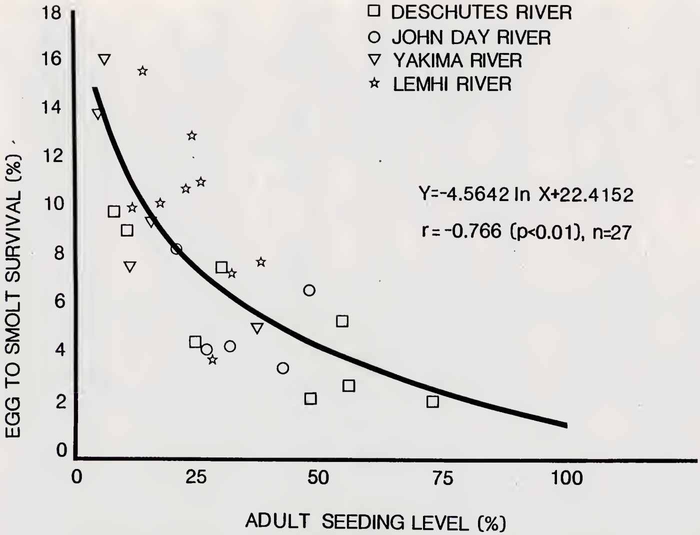
9/ 1 adult X 2,200 eggs X 0.22 survival rate = 484 smolts. 24 adults/484 smolts = 0.0496.

10/ The assumption was also made that natural production in the three subbasins was limited by smolt rearing habitat rather than spawning habitat (egg capacity). For this reason, egg capacity was not estimated but set at a very high level so that production would be limited first by the smolt capacity.

FIGURE 5



REGRESSION OF EGG-TO-SMOLT SURVIVAL RATE ON SEEDING LEVEL OF SPRING CHINOOK FROM FOUR SUB-BASINS OFZTHE COLUMBIA RIVER.

Appendix A. For Scenario B, the intent was to simulate a range of average per project survival rates without reference to a particular set of management actions. A range in project survival rates was obtained by manipulating the reservoir mortality, fish guiding efficiency, and the proportion of smolts transported.

c. Output Variable.

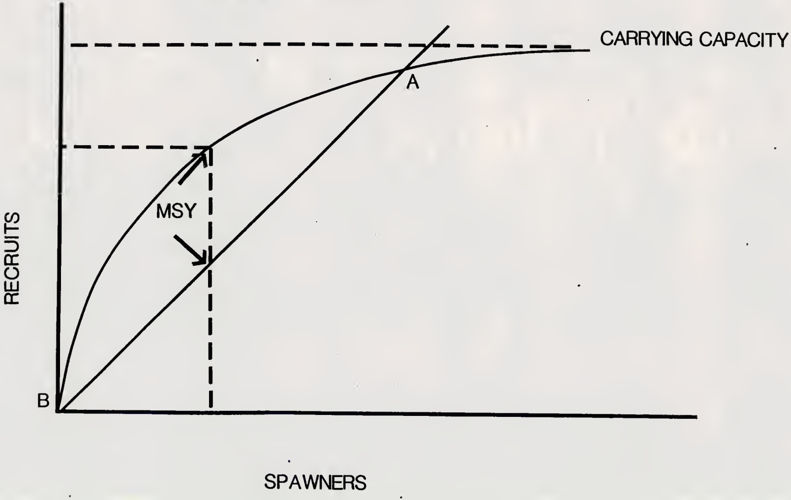
The response of the model was measured in terms of the maximum sustained yield (MSY). MSY is the maximum number of fish produced by the population in excess of the number of fish required to spawn and reproduce the same population size. It results from density-dependent population increase and the maximum population size (carrying capacity) imposed by the environment. For this reason it is applicable only to natural production. In the model this density dependence is introduced by the use of a Beverton-Holt type relation to determine the smolt survival rate as a function of fry density. The Beverton-Holt function is more conventionally viewed as the relationship between the number of spawners and the number of recruits or adults produced (Figure 6). In Figure 6 it can be seen that as the number of spawners increases, the population size (number of recruits) increases as well, initially at a very high rate, and then at a decreasing rate as the population size approaches the carrying capacity. For any population size, the number of spawners required to reproduce the same population size is given by the diagonal line (A-B in Figure 6). The area between the diagonal line (replacement line) and the curved line showing population size is the number of fish surplus to the needs of reproduction and available for harvest or other needs. Given constant environmental conditions and no harvest, the number of recruits will approach the carrying capacity and reach its maximum. This point of equilibrium is where the diagonal replacement line crosses the curve of population size (point A in Figure 6). It is termed the maximum equilibrium run size. Although this is the maximum population size, the amount of surplus is zero--all recruits are required to maintain the population at this size. The greatest distance between the replacement line and the population line is the MSY (Figure 6). The number of spawners needed to produce the MSY is usually less than half the number needed to produce the maximum equilibrium population size. The number of recruits at MSY is termed the MSY population, and the number of spawners at this point is termed the MSY escapement.

Maintaining the population at the MSY level is frequently the goal of fisheries management, since, as the name implies, it is the population size that will produce that maximum yield or surplus on a sustained basis. MSY is an elusive target for fisheries managers, however, because it assumes constant environmental conditions. Landslides, floods, oceanographic conditions or other environmental changes will change the MSY. Nonetheless, the concept of MSY underlies most escapement goals and management practices. The very limitations of MSY as a management target make it an ideal model parameter for comparing production scenarios because it is sensitive to environmental and management changes, and because it reflects the scenario in terms applicable to fisheries management.

Harvest rate and harvest pattern (allocation) are also reflected in the MSY. Because the allocation of a particular MSY among the various fisheries involves social and legal issues outside the scope of the present analysis, the MSY was measured in terms of adult equivalents at the spawning grounds with no harvest. Adult equivalents is a term used by fisheries managers to express fish at any stage in their life cycle in terms of their potential to return as spawning adults. For instance 1,000 fish in the ocean is equivalent to 400 adult equivalents if the survival rate to spawning is 40 percent. Expressing all yield in terms of adult equivalents normalizes the MSY to a common point. In practice, the MSY was determined by shutting off all harvest in the model, allowing the population to equilibrate, and then increasing terminal harvest to some high rate and allowing the population to re-equilibrate. This data was fitted to a Beverton-Holt function, from which the MSY was calculated.

FIGURE 6

GENERALIZED BEVERTON-HOLT PRODUCTION CURVE



In this analysis, three population statistics were used: the MSY itself, termed the MSY surplus; the MSY as a proportion of the total population size, termed the MSY rate; and the maximum equilibrium run size (point A in Figure 6). The MSY surplus reflects changes in survival rates and the carrying capacity. Because it reflects the carrying capacity it is not comparable as an index of productivity between basins of differing size. MSY rate is independent of carrying capacity and so is comparable between basins. In addition, the MSY rate provides a statistic for comparison of the relative capacity of subbasins to accommodate harvest. The equilibrium run size was provided as a gauge of population size.

2. Results.

Results from the simulations were displayed on three dimensional plots. This allows two independent variables (e.g. natural survival rates, carrying capacity, or passage survival rate) to be displayed simultaneously with the dependent variable of MSY. This also displays the interaction between two independent variables in determining the MSY. Because of the large uncertainties in most of the input data, the intent was to observe the pattern of response from the model rather than the exact value of the response. For this reason, it is best to focus on the topography of the response surface in the plots rather than the value of individual points. The "lay of the land" on these surfaces displays the type of response. For instance, a steeply rising surface indicates a strong response while a flatter surface indicates a weaker response.

The plots were generated using the 3DPLOT and 3DGRID routines in SAS [11] located on the Council's VAX780 computer. The program used a matrix of data points supplied by the simulations and interpolated between them to create smooth surfaces. The model produces a smooth response; irregularities in the surfaces result from rounding errors or interpolations by the SAS program along the edges of the surfaces beyond the range of input data. It should also be noted in the plots that the program interpolates within a given range of the dependent variable and then truncates the surface. This results in the plateaus visible on the tops of some of the surfaces (e.g., Figure 6).

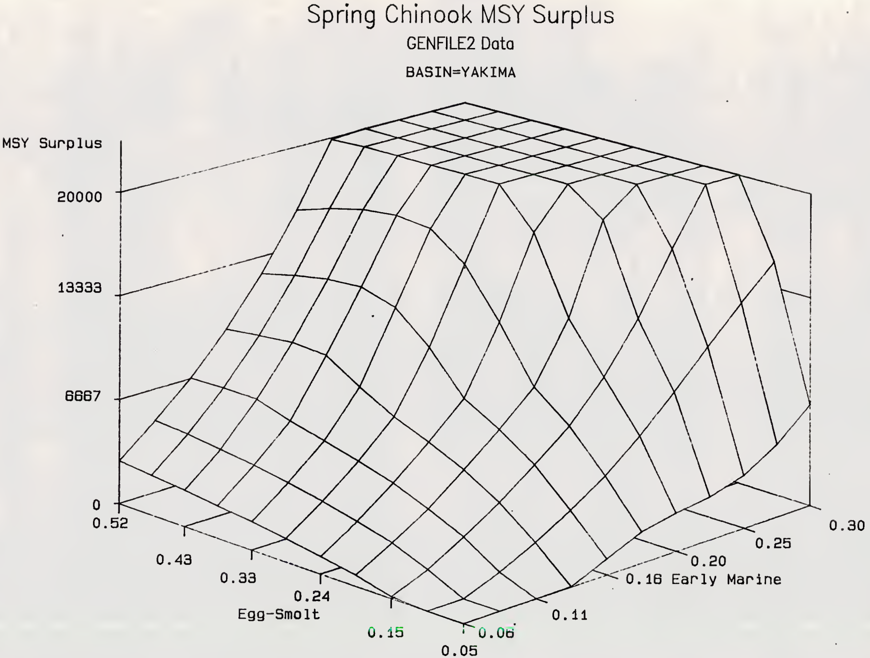
Figures 7-15 display the results from scenario A (Table 6) simulations using egg-smolt and early marine survival rate as the independent variables. Carrying capacity has been set at United States v. Oregon estimates and passage survival simulates present conditions. All harvest was turned off except terminal harvest as explained above to estimate the MSY.

In the Yakima, the value of the two natural survival rates had a marked effect on the MSY. Probably because of the importance of the juvenile survival rate in the Beverton-Holt function, the MSY rate (Figure 8) appeared more affected by the egg-smolt survival rate than by the early marine survival rate. The equilibrium run size, however, was more affected by the early marine survival rate than by the egg-smolt survival rate (Figure 9). This is because the shape of the Beverton-Holt function (Figure 6) produces a flattening of the effect of egg-smolt survival rate. The early marine survival rate is not so constrained since it operates as a simple multiplier in the model.

The results from the scenario A simulations of the Grande Ronde appeared similar in many respects to those of the Yakima (Figures 10-12). The value of the egg-smolt and early ocean survival rates had a marked effect on the MSY and the equilibrium run size. An important difference, however, is in the size of the MSY surplus and the equilibrium run size in the Grande Ronde and the Yakima. Although the smolt carrying capacity in the Yakima was about four times the smolt carrying capacity in the Grande Ronde, the MSY surplus and the equilibrium run size in the Yakima was on the order of ten times the MSY surplus in the Grande Ronde.

11/ A statistical analysis software package from the SAS Institute, Cary N.C.

FIGURE 7



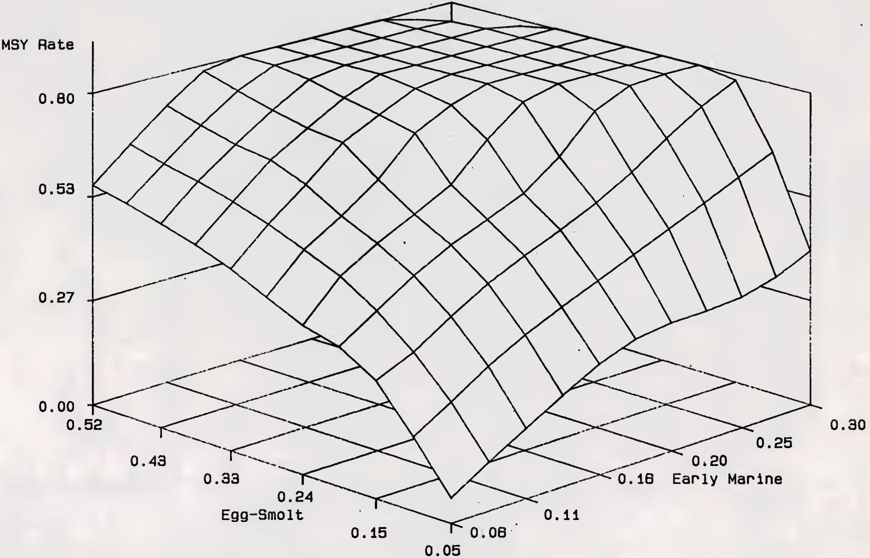
Egg-Smolt= Egg to smolt survival rate
Early Marine= Early marine survival rate

F RE 8

Spring Chinook MSY Rate

GENFILE2 Data

BASIN=YAKIMA



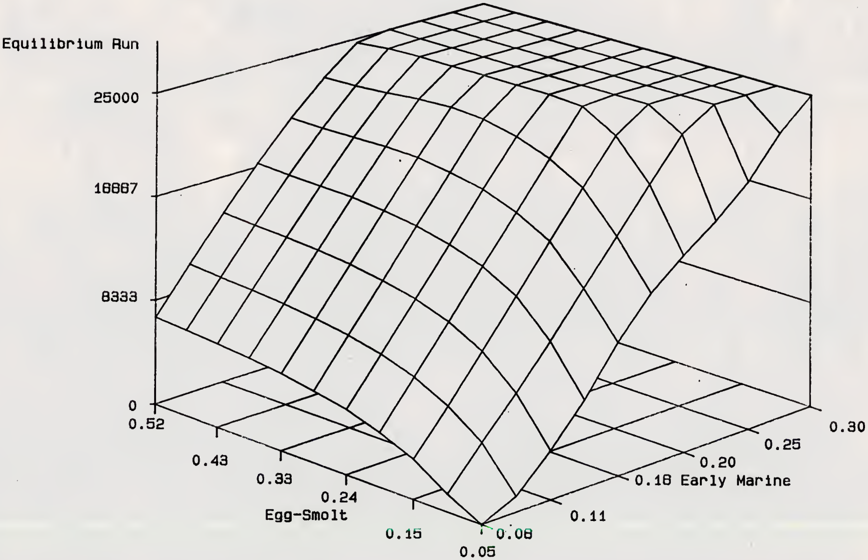
Egg-Smolt= Egg to smolt survival rate
Early Marine= Early marine survival rate

FIGURE 9

Spring Chinook Equilibrium Run Size

GENFILE2 Data

BASIN=YAKIMA



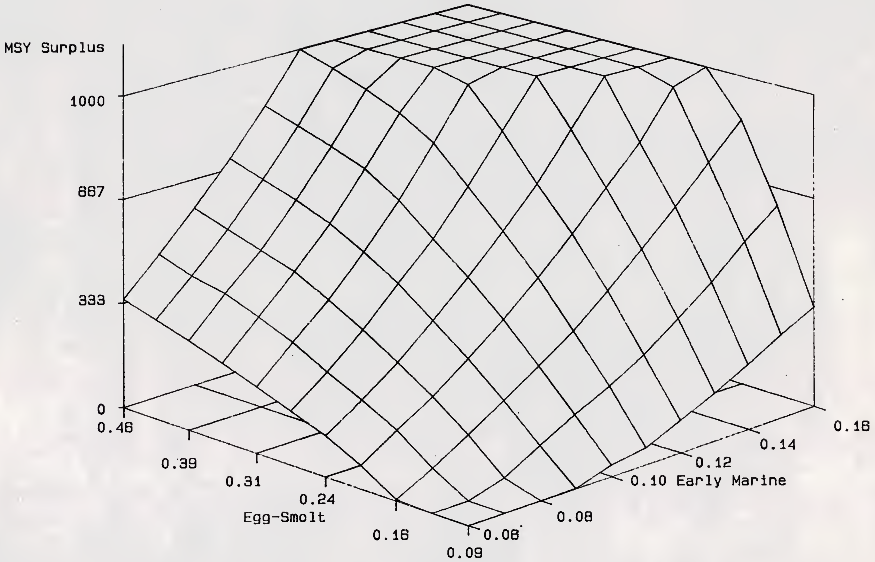
Egg-Smolt= Egg to smolt survival rate
Early Marine= Early marine survival rate

FIGURE 10

Spring Chinook MSY Surplus

GENFILE2 Data

BASIN=G.RONDE



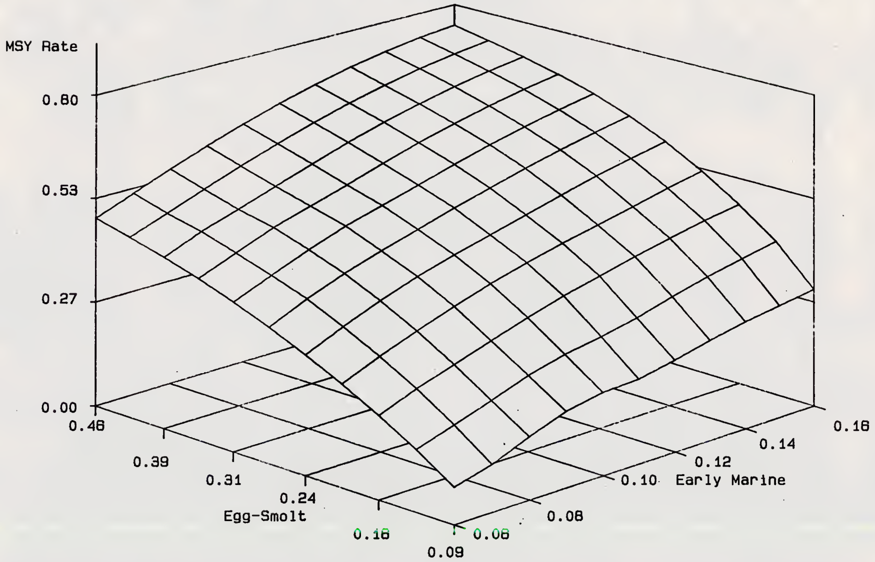
Egg-Smolt= Egg to smolt survival rate
Early Marine= Early marine survival rate

FIGURE 11

Spring Chinook MSY Rate

GENFILE2 Data

BASIN=G.RONDE



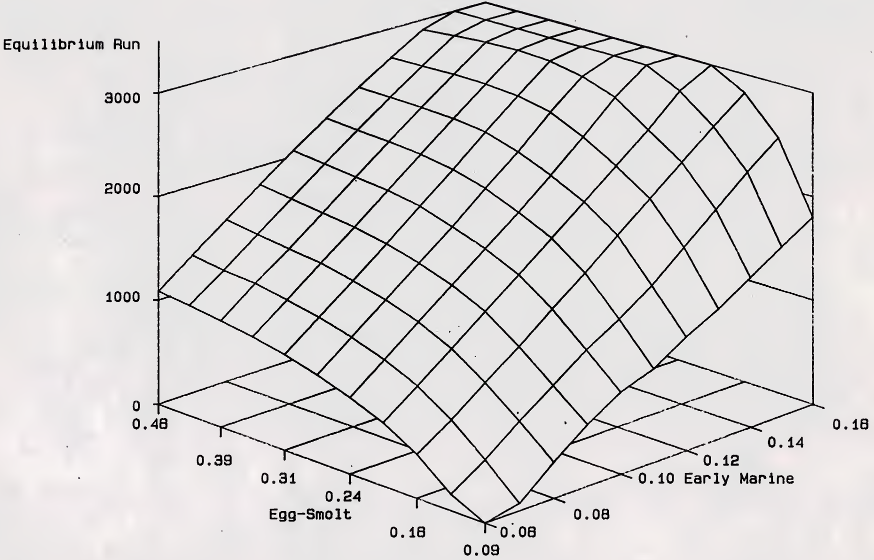
Egg-Smolt= Egg to smolt survival rate
Early Marine= Early marine survival rate

FIGURE 12

Spring Chinook Equilibrium Run Size

GENFILE2 Data

BASIN=G.RONDE



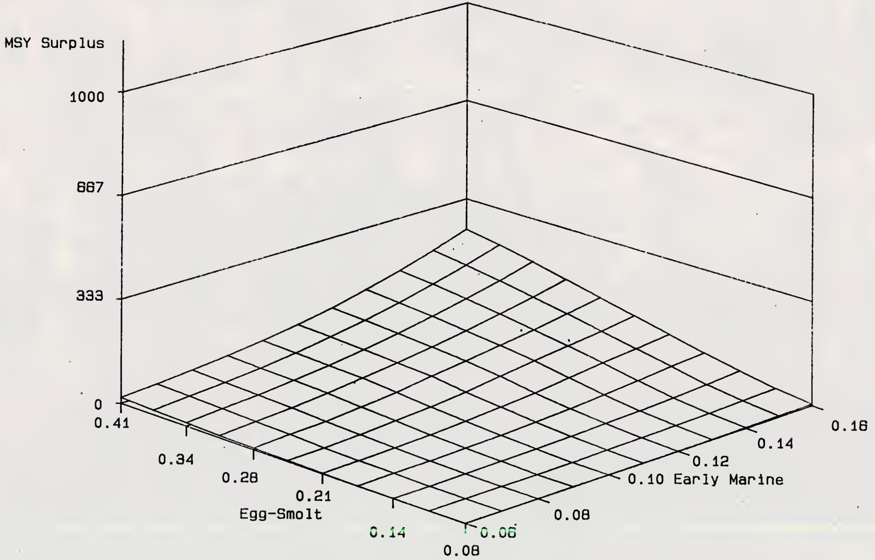
Egg-Smolt= Egg to smolt survival rate
Early Marine= Early marine survival rate

FIGURE 13

Spring Chinook MSY Surplus

GENFILE2 Data

BASIN=METHOW



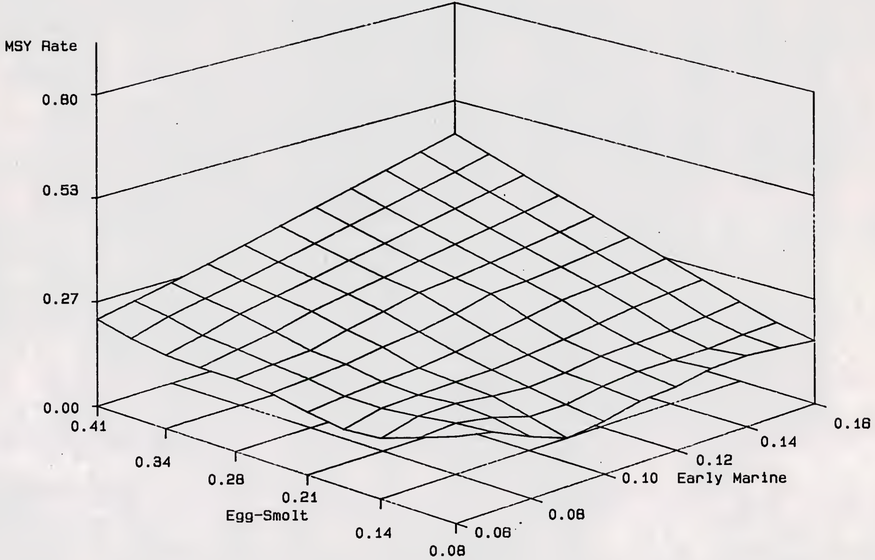
Egg-Smolt= Egg to smolt survival rate
Early Marine= Early marine survival rate

FIG[illegible] 14

Spring Chinook MSY Rate

GENFILE2 Data

BASIN=METHOW



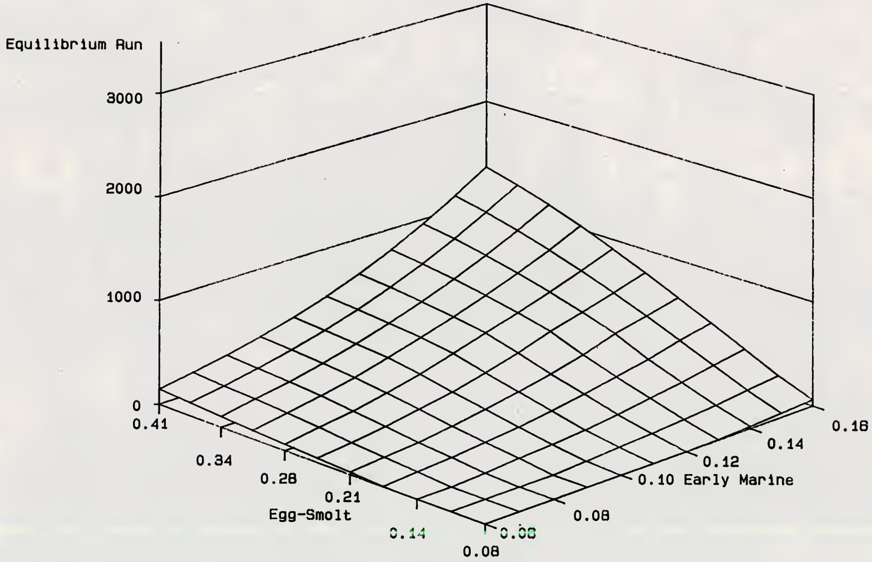
Egg-Smolt= Egg to smolt survival rate
Early Marine= Early marine survival rate

FIGURE 15

Spring Chinook Equilibrium Run Size

GENFILE2 Data

BASIN=METHOW



Egg-Smolt= Egg to smolt survival rate
Early Marine= Early marine survival rate

A different situation is seen in the Scenario A simulations of the Methow (Figures 13-15). The MSY and the equilibrium run size showed virtually no response to change in either of the survival rates (irregularities in the surface of Figure 14 result from errors in rounding very small numbers). Although the Methow and the Grande Ronde had similar smolt carrying capacities. the MSY surplus and the equilibrium run size in the Grande Ronde was much higher than that in the Methow (Figure 13 and 15).

The differences between the simulations of the Methow and those of the Yakima and Grande Ronde rivers are the result of differences in juvenile passage survival rate. The Yakima and the Grande Ronde had similar passage survival rates in the Scenario A simulations. The Yakima lies above only four dams, while most of the spring chinook from the Grande Ronde were transported in the simulations to below Bonneville at relatively low mortality rates. Fish from the Methow, in contrast, were passed through nine dams, and only a small portion were transported from McNary Dam. The passage survival rates appeared to form a "bottle-neck" in the survival of spring chinook from the Methow that overshadowed the effect of change in the juvenile or adult survival rates. Uncertainty (or change if such was possible) in the value of the natural survival rates does not appear to be an important factor in predicting the effect of management alternatives in the Methow as long as passage survival conditions resemble those simulated in this exercise.

The difference in the MSY surplus and the equilibrium run size between the Yakima and the Grande Ronde is the result of differences in adult passage survival rate. Like the juvenile passage survival rate, the adult passage survival rate acts as a power function, and decreases rapidly as the number of dams increases. This factor appeared to hold the size of the Grande Ronde population at a lower level, relative to the smolt carrying capacity. than occurred in the Yakima simulations. Given that the two basins had similar juvenile passage survival rates (because of the effect of the assummed transport benefit ratio on survival of fish from the Grande Ronde) adult passage survival rate appeared to be more important than juvenile passage survival rate in determining the natural production in the Grande Ronde subbasin.

The results from the Scenario B simulations (Table 6) are shown in Figures 16-18. As noted above, the MSY rate is not affected by changing the carrying capacity. and so only the MSY surplus was used in this portion of the analysis. Juvenile and early ocean survival rates were set at the "most probable" estimates explained above, while carrying capacity and project survival rate were varied over a range. Both of these variables represent change resulting from possible management actions or uncertainty in the value of the parameters. Harvest was set to zero except for terminal harvest as needed to determine the MSY as explained above.

The influence of the juvenile passage survival rate on MSY found in the Scenario A simulations also was present in the simulations of carrying capacity. In the Yakima. the MSY surplus was most affected by changing the carrying capacity. change in the average per project survival rate had little effect (Figure 16). In the Grande Ronde and the Methow. however. change in the carrying capacity at low values of average per project survival had very little effect on the MSY surplus, while the average per project survival rate did change the MSY surplus (Figures 17 and 18).

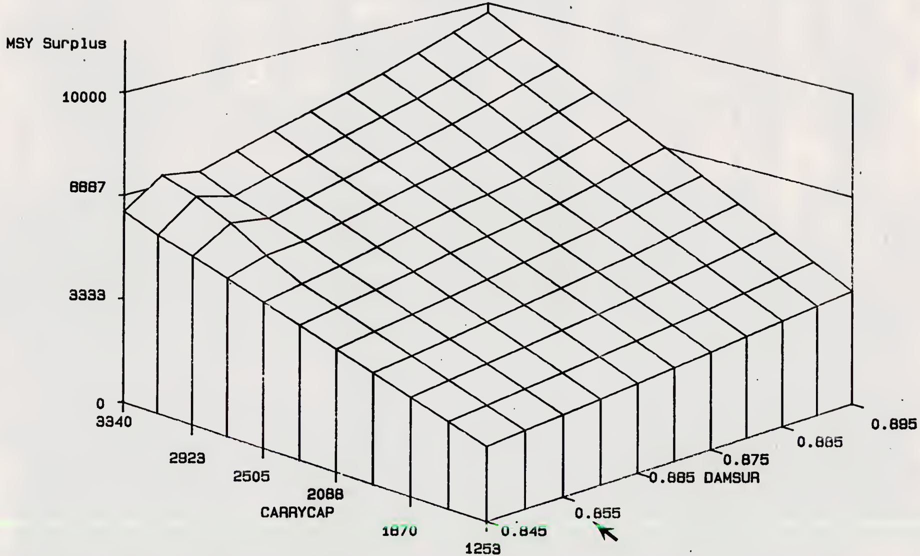
The effect of carrying capacity on the MSY increased as the project survival rate increased for the Methow and Grande Ronde subbasins. This was because the simulation utilized system survival rate; project survival rate relates to system survival rate as a power function based on the number of dams. At high juvenile passage survival rates, the effect of carrying capacity in the Methow and the Grande Ronde was similar to that seen in the Yakima. In Figures 16-18 the average per project juvenile survival rate used in the Scenario A simulations, which reflected present (1987) passage conditions, is marked with an arrow. Under the passage conditions assumed in Scenario A. the Grande Ronde responded to changes in carrying capacity in a manner similar to the Yakima. while the Methow remained insensitive to changes in carrying capacity. As was the case in the Scenario A simulations. system passage survival rate limited

FIGURE 16

Spring Chinook MSY Surplus

Scenario B Simulations

BASIN=YAKIMA



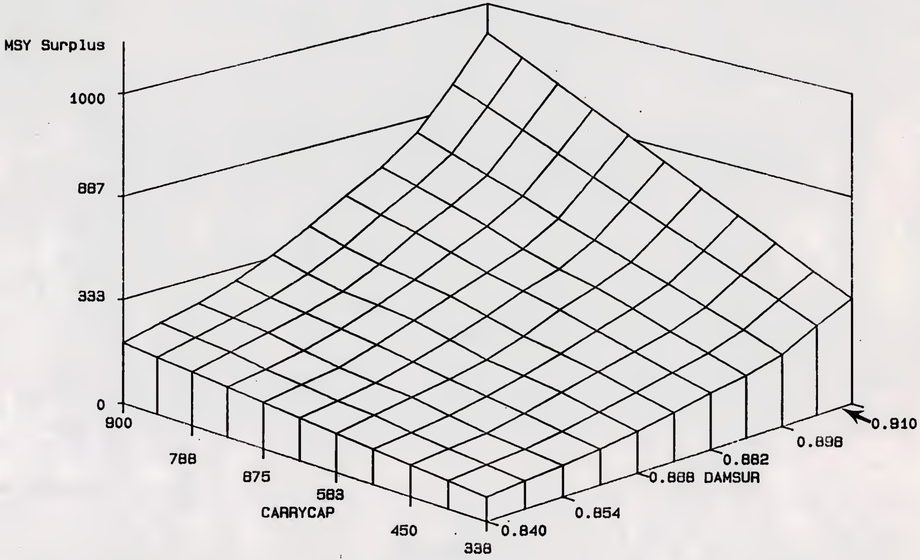
DAMSUR= Average Project Survival Rate
CARRYCAP=Smolt Carrying Capacity (1,000s)

FIGURE 17

Spring Chinook MSY Surplus

Scenario B Simulations

BASIN=GRONDE



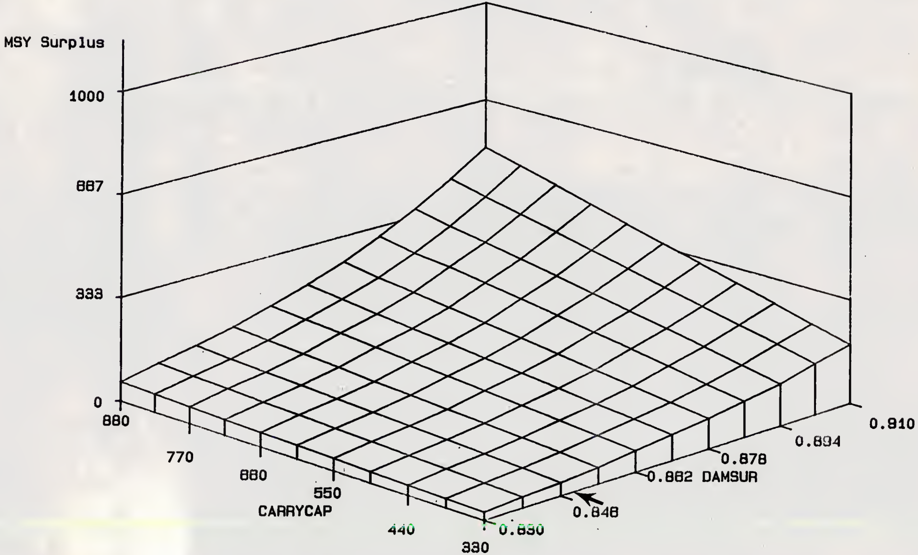
DAMSUR= Average Project Survival Rate
CARRYCAP=Smolt Carrying Capacity (1,000s)

FIGURE 18

Spring Chinook MSY Surplus

Scenario B Simulations

BASIN=METHOW



DAMSUR= Average Project Survival Rate
CARRYCAP=Smolt Carrying Capacity (1,000s)

production in the Methow to a greater degree than did the natural productivity factors of juvenile and adult survival rate and carrying capacity.

Adult passage survival also appeared to affect the MSY in the upper subbasins as it did in the Scenario A simulations. Production (MSY surplus) was much less in the Methow, relative to the carrying capacity, than it was in the Yakima. This was true even at the higher levels of juvenile passage survival in the Grande Ronde. The cumulative effect of adult passage at eight dams forced a relatively lower equilibrium in the Grande Ronde.

3. Discussion.

This analysis was intended to provide some insight into system and subbasin factors affecting natural production of spring chinook in the Columbia basin. It utilized the Council's production planning model to organize the available data and simulate the effect of uncertainty and change in some key parameters.

The results have indicated that system parameters, specifically survival rates at mainstem hydroelectric projects, can influence how natural factors affect the productivity of the subbasins. This results in a different ranking of factors affecting production between subbasins. For this reason, differences may exist in the effect of uncertainty on the one hand and the effectiveness of some management measures on the other. Based on these simulations, the hypothesis is advanced that under presumed present (1987) levels of survival past mainstem hydroelectric projects, the effect of uncertainty in natural survival parameters and carrying capacity should have a strong impact on the projections of outcomes from management actions in the Yakima and the Grande Ronde rivers. Projections for the Methow, however, should be relatively insensitive to uncertainty in the value of these parameters, although production measures in the Methow will be highly subject to juvenile passage survival rates. Similarly, change in the carrying capacity in the Yakima and the Grande Ronde rivers, by increasing or decreasing the available habitat, for instance, should strongly affect the MSY, whereas change in the carrying capacity in the Methow should have little effect. The differences result from differences in juvenile survival rate past the mainstem hydroelectric projects. In areas of the basin with poor juvenile passage conditions, passage survival rate, not natural productivity factors, appear to limit natural productivity of spring chinook. On the other hand, natural production of spring chinook in upper river basins that have relatively good juvenile passage conditions may be limited by adult passage conditions.

While these hypotheses are advanced based on the results of the simulations, they can only be tested by field research. Because the model is a summary of present theories of how natural production operates in the Columbia basin, field evidence refuting hypotheses generated by the model could indicate possible errors in our thinking that would require re-formulation of the model.

These hypotheses require that the values used in this analysis, particularly the mainstem passage survival rates, be correct, and that the variables examined are of primary importance in determining natural production. However, in the case of the Methow, the conclusion appears to be robust. In Figure 17, even a reasonable amount of uncertainty about the point estimate of present juvenile passage survival rate would not change the conclusion. Similarly, the simulations of the Yakima were not sensitive to juvenile passage survival rates. On the other hand, the conclusion regarding the Grande Ronde is highly dependent on the assumption that the transport benefit ratio for spring chinook from Lower Granite Dam is at least 2:1 on an average flow year. Data regarding the actual benefit ratio is extremely variable and inconclusive. The value used here was a judgment as to a "most probable" estimate. If the actual benefit ratio is appreciably less, the situation in the Grande Ronde is quite different than is portrayed here. In this case, the Grande Ronde would appear to be more similar to the Methow than the Yakima with respect to the importance of natural survival rates and carrying capacity in determining production.

An ancillary purpose of this analysis was to experiment with ways of using modeling to aid systemwide planning of salmon and steelhead production. The results to date, indicate that, if used properly, the model can help organize our thinking and provide useful insights. In addition, the model can be used in an iterative process between hypothesis generation and field research.[12] While on reflection the conclusions from the analysis may seem self-evident, they have never been explicitly stated, nor has the available data been organized in a systematic fashion to demonstrate the processes shown here. Future work will continue along this vein, and include the effect of harvest rate and pattern, in a manner similar to that used here to examine the effect of mainstem passage conditions. The analysis will also be expanded to include other species. Refinement of the model and the simulation techniques will permit the analysis of hatchery production as well.

C. INPUT PARAMETERS AND ASSUMPTIONS FOR USE IN SUBBASIN PLANNING FOR MAINSTEM PASSAGE SURVIVAL OF JUVENILE ANADROMOUS FISH MIGRATING IN AVERAGE WATER CONDITIONS:

The following tables (Tables 7 through 12) are listings of mainstem parameters and assumptions proposed for discussion and use in the subbasin planning process. These tables are consistent with the Council's current mainstem passage policies, as described in the System Objective and Policies Issue Paper. Passage parameters and assumptions listed for the eight federal lower Snake and Columbia river hydroelectric projects were identified in 1985-1986 by the Council's Mainstem Passage Advisory Committee. The parameters listed for the five mid-Columbia public utility district projects were identified in study findings submitted to the Federal Energy Regulatory Commission by the Mid-Columbia Coordinating Committee, unless otherwise noted. Note that Tables 7 through 9 provide parameters and assumptions for existing juvenile fish passage conditions at projects in the lower Snake, lower Columbia and mid-Columbia river reaches, and Tables 10 through 12 represent parameters and assumptions for anticipated or attainable fish passage conditions in 1992 at projects in each of the three mainstem reaches, assuming juvenile fish bypass facilities are installed and operational at all projects.

12/ An example of this would be the use of the model for system evaluation and monitoring and research planning (section 205 of the Draft Amendment Document).

TABLE 7
EXISTING (1987) PASSAGE CONDITIONS (LOWER SNAKE RIVER)[1]

INPUT PARAMETERS	MAINSTEM HYDROELECTRIC PROJECT Lower Granite	Little Goose	Lower Monumental	Ice Harbor
a. Spill Survival				
Yearling Chinook	.98	.98	.98	.98
Subyearling Chinook	.98	.98	.98	.98
Steelhead	.98	.98	.98	.98
b. Bypass Survival				
Yearling Chinook	.98	.98	.98	.98
Subyearling Chinook	.98	.98	.98	.98
Steelhead	.98	.98	.98	.98
c. Turbine Survival				
Yearling Chinook	.85	.85	.85	.85
Subyearling Chinook	.85	.85	.85	.85
Steelhead	.85	.85	.85	.85
d. Reservoir Survival[2]				
Yearling Chinook				
Subyearling Chinook				
Steelhead				
e. Fish Guidance Efficiency				
Yearling Chinook	.50	.50	.03	.51[3]
Subyearling Chinook	.50	.50	.03	.51
Steelhead	.74	.74	.03	.51

[1] Same coefficients and parameters used by Mainstem Passage Advisory Committee (MPAC).

[2] Data not included because reservoir survival is a function of flow. Reservoir mortality was calculated based on a minimum reservoir mortality rate of 0.002 per mile for flows greater than 265 kcfs at The Dalles Dam and increasing linearly to a maximum reservoir mortality rate of 0.02 per mile at 0 flow at The Dalles Dam. Reservoir survival was determined by taking the complement of reservoir mortality to the power of the reservoir length.

[3] Sluiceway efficiency.

TABLE 7 – Continued

INPUT PARAMETERS	MAINSTEM HYDROELECTRIC PROJECT Lower Granite	Little Goose	Lower Monumental	Ice Harbor
f. Separator Efficiency				
Yearling Chinook	1.0	0.2	N/A	N/A
Subyearling Chinook	1.0	1.0	N/A	N/A
Steelhead	1.0	0.8	N/A	N/A
g. Transport Survival[4]				
Yearling Chinook	.95	.95	N/A	N/A
Subyearling Chinook	.95	.95	N/A	N/A
Steelhead	.95	.95	N/A	N/A
h. Transport Benefit Ratio[5]				
Yearling Chinook				
Subyearling Chinook				
Steelhead				
i. Average Daily Spill %[6]				
Yearling Chinook	14.7	14.7	24.9	12.3
Subyearling Chinook	0.0	0.0	13.0	0.0
Steelhead	14.7	14.7	24.9	12.3
j. Spill Efficiency[7]				
Yearling Chinook	y=x	y=x	y=x	y=x
Subyearling Chinook	y=x	y=x	y=x	y=x
Steelhead	y=x	y=x	y=x	y=x

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[4] Short-term survival of transported juveniles to below Bonneville Dam in truck or barge.

[5] To be determined in consultation with MPAC.

[6] To achieve at least 90 percent per project survival rate.

[7] Fish spill efficiency: y = percent fish spilled; x = percent river spilled (instantaneous).

TABLE 8
EXISTING (1987) PASSAGE CONDITIONS (LOWER COLUMBIA RIVER)[1]

	MAINSTEM HYDROELECTRIC PROJECT				
INPUT PARAMETERS	McNary	John Day	The Dalles	Bonneville I	Bonneville II
a. Spill Survival					
Yearling Chinook	.98	.98	.98	.98	N/A
Subyearling Chinook	.98	.98	.98	.98	N/A
Steelhead	.98	.98	.98	.98	N/A
b. Bypass Survival					
Yearling Chinook	.98	.98	.98	.98	.98
Subyearling Chinook	.98	.98	.98	.98	.98
Steelhead	.98	.98	.98	.98	.98
c. Turbine Survival					
Yearling Chinook	.85	.85	.85	.85	.85
Subyearling Chinook	.85	.85	.85	.85	.85
Steelhead	.85	.85	.85	.85	.85
d. Reservoir Survival[2]					
Yearling Chinook					N/A
Subyearling Chinook					N/A
Steelhead					N/A
e. Fish Guidance Efficiency					
Yearling Chinook	.74	.72	.40[3]	.76	.19
Subyearling Chinook	.38	.20	.40	.72	.24
Steelhead	.76	.85	.40	.78	.35

[1] Same coefficients and parameters used by Mainstem Passage Advisory Committee (MPAC).

[2] Data not included because reservoir survival is a function of flow. Reservoir mortality was calculated based on a minimum reservoir mortality rate of 0.002 per mile for flows greater than 265 kcfs at The Dalles Dam and increasing linearly to a maximum reservoir mortality rate of 0.02 per mile at 0 flow at The Dalles Dam. Reservoir survival was determined by taking the complement of reservoir mortality to the power of the reservoir length.

[3] Sluiceway efficiency.

TABLE 8--Continued

INPUT PARAMETERS	MAINSTEM HYDROELECTRIC PROJECT McNary	John Day	The Dalles	Bonneville I	Bonneville II
f. Separator Efficiency					
Yearling Chinook	.20	N/A	N/A	N/A	N/A
Subyearling Chinook	.80	N/A	N/A	N/A	N/A
Steelhead	.80	N/A	N/A	N/A	N/A
g. Transport Survival[4]					
Yearling Chinook	.99	N/A	N/A	N/A	N/A
Subyearling Chinook	.99	N/A	N/A	N/A	N/A
Steelhead	.99	N/A	N/A	N/A	N/A
h. Transport Benefit Ratio[5]					
Yearling Chinook					
Subyearling Chinook					
Steelhead					
i. Average Daily Spill %[6]					
Yearling Chinook	11.2	4.8	4.3	39.2	N/A
Subyearling Chinook	3.2	11.0	3.6	35.0	
Steelhead	11.2	4.8	4.3	39.2	N/A
j. Spill Efficiency[7]					
Yearling Chinook	y=x	y=x	y=x	y=x	N/A
Subyearling Chinook	y=x	y=x	y=x	y=x	N/A
Steelhead	y=x	y=x	y=x	y=x	N/A

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[4] Short-term survival of transported juveniles to below Bonneville Dam in truck or barge.

[5] To be determined in consultation with MPAC.

[6] To achieve at least 90 percent per project survival rate.

[7] Fish spill efficiency: y = percent fish spilled; x = percent river spilled (instantaneous).

TABLE 9
EXISTING (1987) PASSAGE CONDITIONS (MID-COLUMBIA RIVER)[1]

INPUT PARAMETERS	MAINSTEM HYDROELECTRIC PROJECT					
	Wells	Rocky Reach	Rock Island I	Rock Island II	Wanapum	Priests Rapids
a. Spill Survival						
Yearling Chinook	1.0	1.0	1.0	N/A	1.0	1.0
Subyearling Chinook	1.0	1.0	1.0	N/A	1.0	1.0
Steelhead	1.0	1.0	1.0	N/A	1.0	1.0
b. Bypass Survival						
Yearling Chinook	N/A	N/A	N/A	N/A	N/A	N/A
Subyearling Chinook	N/A	N/A	N/A	N/A	N/A	N/A
Steelhead	N/A	N/A	N/A	N/A	N/A	N/A
c. Turbine Survival						
Yearling Chinook	.85	.85	.89	.94[2]	.89	.89
Subyearling Chinook	.85	.85	.89	.94	.89	.89
Steelhead	.85	.85	.89	.96	.89	.89
d. Reservoir Survival[3]						
Yearling Chinook						
Subyearling Chinook						
Steelhead						

[1] Coefficients and parameters identified by findings of the Mid-Columbia Coordinating Committee submitted to FERC, unless otherwise noted.

[2] Point estimates of turbine mortality for Rock Island II based on a FERC administrative law judge's "Initial Decision Establishing Interim Procedures for Rock Island Project," (January 31, 1986).

[3] To be developed by Council staff at a future date.

TABLE 9--Continued

INPUT PARAMETERS	MAINSTEM HYDROELECTRIC PROJECT Wells	Rocky Reach	Rock Island I	Rock Island II	Wanapum	Priests Rapids
e. Fish Guidance Efficiency						
Yearling Chinook	N/A	N/A	N/A	N/A	N/A	N/A
Subyearling Chinook	N/A	N/A	N/A	N/A	N/A	N/A
Steelhead	N/A	N/A	N/A	N/A	N/A	N/A
f. Separator Efficiency						
Yearling Chinook	N/A	N/A	N/A	N/A	N/A	N/A
Subyearling Chinook	N/A	N/A	N/A	N/A	N/A	N/A
Steelhead	N/A	N/A	N/A	N/A	N/A	N/A
g. Transport Survival						
Yearling Chinook	N/A	N/A	N/A	N/A	N/A	N/A
Subyearling Chinook	N/A	N/A	N/A	N/A	N/A	N/A
Steelhead	N/A	N/A	N/A	N/A	N/A	N/A
h. Transport Benefit Ratio						
Yearling Chinook	N/A	N/A	N/A	N/A	N/A	N/A
Subyearling Chinook	N/A	N/A	N/A	N/A	N/A	N/A
Steelhead	N/A	N/A	N/A	N/A	N/A	N/A
i. Average Daily Spill %[4]						
Yearling Chinook	8.8	10	18	N/A	24	19
Subyearling Chinook	0	0	0	N/A	0	0
Steelhead	8.8	10	18	N/A	24	19

[4]Based on the annual interim juvenile fish passage plans specified in the 1984-87 FERC Mid-Columbia Settlement Agreement or, in the case of Rock Island Dam, as agreed to by Chelan County Public Utility District, the FERC and the fishery agencies and tribes. These spill levels are expected to achieve at least a 90 percent project survival rate.

TABLE 9--Continued

	Wells	Rocky Reach	Rock Island I & II	Wanapum	Priest Rapids
	MAINSTEM HYDROELECTRIC PROJECT				
j. Spill Efficiency[5]					
Yearling Chinook	87% fish/20% spill 74% fish/20% spill	$y = 0.663\ x$	$y = \exp^{.054}$	$y = 15.545 \ln(x)$	$\ln(y) = 0.819 \ln(x)$
Subyearling Chinook	ND	$y = 0.663\ x$	$y = \exp^{.054}$	$y = 15.545 \ln(x)$	$\ln(y) = 0.819 \ln(x)$
Steelhead	87% fish/20% spill 74% fish/20% spill	$y = 0.663\ x$	$y = \exp^{.054}$	$y = 15.545 \ln(x)$	$\ln(y) = 0.819 \ln(x)$
k. Fish Passage Distribution					
Yearling Chinook	2000-0400/80%	2000-0600/43%	1900-0700/74%	2000-0600/55%	2000-0600/57%
Subyearling Chinook	2000-0400/58%	2000-0600/43%	1900-0700/74%	2000-0600/55%	2000-0600/57%
Steelhead	2000-0400/56%	2000-0600/43%	1900-0700/74%	2000-0600/55%	2000-0600/57%

[5]Fish spill efficiency: y = percent fish spilled; x = percent river spilled (instantaneous)

TABLE 10 - ATTAINABLE[1] (1992) PASSAGE CONDITIONS (LOWER SNAKE RIVER)

	MAINSTEM HYDROELECTRIC PROJECT			
INPUT PARAMETERS	Lower Granite	Little Goose	Lower Monumental	Ice Harbor
a. Spill Survival				
Yearling Chinook	.98	.98	.98	.98
Subyearling Chinook	.98	.98	.98	.98
Steelhead	.98	.98	.98	.98
b. Bypass Survival				
Yearling Chinook	.98	.98	.98	.98
Subyearling Chinook	.98	.98	.98	.98
Steelhead	.98	.98	.98	.98
c. Turbine Survival				
Yearling Chinook	.85	.85	.85	.85
Subyearling Chinook	.85	.85	.85	.85
Steelhead	.85	.85	.85	.85
d. Reservoir Survival[2]				
Yearling Chinook				
Subyearling Chinook				
Steelhead				
e. Fish Guidance Efficiency[3]				
Yearling Chinook	.74	.74	.75	.70
Subyearling Chinook	.50	.50	.50	.50
Steelhead	.82	.80	.80	.80

[1] Based on the assumption that juvenile fish bypass facilities are installed and operating efficiently at all projects.

[2] Data not included because reservoir survival is a function of flow. Reservoir mortality was calculated based on a minimum reservoir mortality rate of 0.002 per mile for flows greater than 265 kcfs at The Dalles Dam and increasing linearly to a maximum reservoir mortality rate of 0.02 per mile at 0 flow at The Dalles Dam. Reservoir survival was determined by taking the complement of reservoir mortality to the power of the reservoir length.

[3] Based on prototype screen research by the Corps on attainable fish guidance efficiencies by the year 1992; assumes minimum fish guidance efficiencies of 70 percent for yearling chinook, 50 percent for subyearling chinook and 80 percent for steelhead, unless test results have indicated higher guidance efficiencies.

TABLE 10--Continued

INPUT PARAMETERS	Lower Granite	Little Goose	Lower Monumental	Ice Harbor
	MAINSTEM HYDROELECTRIC PROJECT			
f. Separator Efficiency[4]				
Yearling Chinook	.55	.11	N/A	N/A
Subyearling Chinook	ND	ND	N/A	N/A
Steelhead	ND	ND	N/A	N/A
g. Transport Survival[5]				
Yearling Chinook	.95	.95	N/A	N/A
Subyearling Chinook	.95	.95	N/A	N/A
Steelhead	.95	.95	N/A	N/A
h. Transport Benefit Ratio[6]				
Yearling Chinook				
Subyearling Chinook				
Steelhead				
i. Average Daily Spill %[7]				
Yearling Chinook	3.4	3.4	3.4	11.6
Subyearling Chinook	0	0	0	0
Steelhead	3.4	3.4	3.4	11.6
j. Spill Efficiency[8]				
Yearling Chinook	y=x	y=x	y=x	y=x
Subyearling Chinook	y=x	y=x	y=x	y=x
Steelhead	y=x	y=x	y=x	y=x

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[4] Based on collection and transportation of the same proportion of juveniles as in existing condition, given improved fish guidance efficiencies; or needs to be determined.

[5] Short-term survival of transported juveniles to below Bonneville Dam in a truck or barge.

[6] To be determined in consultation with MPAC.

[7] Based on inadvertent spill only in average water conditions.

[8] Fish spill efficiency: y = percent fish spilled; x = percent river spilled (instantaneous).

TABLE 11 -- ATTAINABLE[1] (1992) PASSAGE CONDITIONS (LOWER COLUMBIA RIVER)

	MAINSTEM HYDROELECTRIC PROJECT				
INPUT PARAMETERS	McNary	John Day	The Dalles	Bonneville I	Bonneville II
a. Spill Survival					
Yearling Chinook	.98	.98	.98	.98	N/A
Subyearling Chinook	.98	.98	.98	.98	N/A
Steelhead	.98	.98	.98	.98	N/A
b. Bypass Survival					
Yearling Chinook	.98	.98	.98	.98	.98
Subyearling Chinook	.98	.98	.98	.98	.98
Steelhead	.98	.98	98	.98	.98
c. Turbine Survival					
Yearling Chinook	.85	.85	.85	.85	.85
Subyearling Chinook	.85	.85	.85	.85	.85
Steelhead	.85	.85	.85	.85	.85
d. Reservoir Survival[2]					
Yearling Chinook					
Subyearling Chinook					
Steelhead					
e. Fish Guidance Efficiency[3]					
Yearling Chinook	.74	.72	.70	.76	.70
Subyearling Chinook	.50	.50	.50	.72	.50
Steelhead	.87	.85	.80	.80	80

[1] Based on the assumption that juvenile fish bypass facilities are installed and operating efficiently at all projects.

[2] Data not included because reservoir survival is a function of flow. Reservoir mortality was calculated based on a minimum reservoir mortality rate of 0.002 per mile for flows greater than 265 kcfs at The Dalles Dam and increasing linearly to a maximum reservoir mortality rate of 0.02 per mile at 0 flow at The Dalles Dam. Reservoir survival was determined by taking the complement of reservoir mortality to the power of the reservoir length.

[3] Based on prototype screen research by the Corps on attainable fish guidance efficiencies by the year 1992; assumes minimum fish guidance efficiencies of 70 percent for yearling chinook, 50 percent for subyearling chinook and 80 percent for steelhead, unless test results have indicated higher guidance efficiencies.

TABLE 11--Continued

INPUT PARAMETERS	MAINSTEM HYDROELECTRIC PROJECT McNary	John Day	The Dalles	Bonneville I	Bonneville II
f. Separator Efficiency[4]					
Yearling Chinook	.18	N/A	N/A	N/A	N/A
Subyearling Chinook	ND	N/A	N/A	N/A	N/A
Steelhead	ND	N/A	N/A	N/A	N/A
g. Transport Survival[5]					
Yearling Chinook	.99	N/A	N/A	N/A	N/A
Subyearling Chinook	.99	N/A	N/A	N/A	N/A
Steelhead	.99	N/A	N/A	N/A	N/A
h. Transport Benefit Ratio[6]					
Yearling Chinook					
Subyearling Chinook					
Steelhead					
i. Average Daily Spill %[7]					
Yearling Chinook	11.2	4.8	1.2	5.7	N/A
Subyearling Chinook	3.2	0.3	0	0.4	N/A
Steelhead	11.2	4.8	1.2	5.7	N/A
j. Spill Efficiency[8]					
Yearling Chinook	y=x	y=x	y=x	y=x	N/A
Subyearling Chinook	y=x	y=x	y=x	y=x	N/A
Steelhead	y=x	y=x	y=x	y=x	N/A

[4] Based on collection and transportation of the same proportion of juveniles as in existing condition, given improved fish guidance efficiencies; or needs to be determined.

[5] Short-term survival of transported juveniles to below Bonneville Dam in a truck or barge.

[6] To be determined in consultation with MPAC.

[7] Based on inadvertent spill only in average water conditions.

[8] Fish spill efficiency: y = percent fish spilled; x = percent river spilled (instantaneous).

TABLE 12 -- ATTAINABLE (1992) PASSAGE CONDITIONS (MID-COLUMBIA RIVER)[1]

INPUT PARAMETERS	Wells	Rocky Reach	Rock Island I	Rock Island II	Wanapum	Priests Rapids
	MAINSTEM HYDROELECTRIC PROJECT					
a. Spill Survival						
Yearling Chinook	1.0	1.0	1.0	N/A	1.0	1.0
Subyearling Chinook	1.0	1.0	1.0	N/A	1.0	1.0
Steelhead	1.0	1.0	1.0	N/A	1.0	1.0
b. Bypass Survival						
Yearling Chinook	N/A	.98	.98	.98	.98	.98
Subyearling Chinook	N/A	.98	.98	98	.98	.98
Steelhead	N/A	.98	.98	.98	.98	.98
c. Turbine Survival						
Yearling Chinook	.85	.85	.89	.94[2]	.89	.89
Subyearling Chinook	.85	.85	.89	.94	.89	.89
Steelhead	.85	.85	.89	.96	.89	.89
d. Reservoir Survival[3]						
Yearling Chinook						
Subyearling Chinook						
Steelhead						

[1] Assumes juvenile fish bypass facilities are installed and operating efficiently at all projects; coefficients and parameters identified by findings of the Mid-Columbia Coordinating Committee submitted to FERC, unless otherwise noted.

[2] Point estimates of turbine mortality for Rock Island II based on a FERC administrative law judge's "Initial Decision Establishing Interim Procedures for Rock Island Project," (January 31, 1986).

[3] To be determined by Council staff at a future date.

TABLE 12--Continued

INPUT PARAMETERS	Wells	Rocky Reach	Rock Island I	Rock Island II	Wanapum	Priests Rapids
	MAINSTEM HYDROELECTRIC PROJECT					
e. Fish Guidance Efficiency[4]						
Yearling Chinook	.70	.70	.70	.70	.70	.70
Subyearling Chinook	.50	.50	.50	.50	.50	.50
Steelhead	.80	.80	.80	80	.80	.80
f. Separator Efficiency						
Yearling Chinook	N/A	N/A	N/A	N/A	N/A	N/A
Subyearling Chinook	N/A	N/A	N/A	N/A	N/A	N/A
Steelhead	N/A	N/A	N/A	N/A	N/A	N/A
g. Transport Survival						
Yearling Chinook	N/A	N/A	N/A	N/A	N/A	N/A
Subyearling Chinook	N/A	N/A	N/A	N/A	N/A	N/A
Steelhead	N/A	N/A	N/A	N/A	N/A	N/A
h. Transport Benefit Ratio						
Yearling Chinook	N/A	N/A	N/A	N/A	N/A	N/A
Subyearling Chinook	N/A	N/A	N/A	N/A	N/A	N/A
Steelhead	N/A	N/A	N/A	N/A	N/A	N/A
i. Average Daily Spill %[5]						
Yearling Chinook	0.0	0.0	N/A	0.0	0.0	0.0
Subyearling Chinook	0.0	0.0	N/A	0.0	0.0	0.0
Steelhead	0.0	0.0	N/A	0.0	0.0	0.0

[4]Based on prototype screen research by the Corps on attainable fish guidance efficiencies by the year 1992; assumes minimum fish guidance efficiencies of 70 percent for yearling chinook, 50 percent for subyearling chinook and 80 percent for steelhead.

[5]Based on inadvertent spill only in average water conditions.

TABLE 12--Continued

	Wells	Rocky Reach	Rock Island I & II	Wanapum	Priest Rapids
		MAINSTEM HYDROELECTRIC PROJECTS			
j. Spill Efficiency[6]					
Yearling Chinook	87% fish/20% spill 74% fish/20% spill	$y = 0.663\,x$	$y = exp^{.054}$	$y = 15.545\ln(x)$	$\ln(y) = 0.819\ln(x)$
Subyearling Chinook	ND	$y = 0.663\,x$	$y = exp^{.054}$	$y = 15.545\ln(x)$	$\ln(y) = 0.819\ln(x)$
Steelhead	87% fish/20% spill 74% fish/20% spill	$y = 0.663\,x$	$y = exp^{.054}$	$y = 15.545\ln(x)$	$\ln(y) = 0.819\ln(x)$
k. Fish Passage Distribution					
Yearling Chinook	2000-0400/80%	2000-0600/43%	1900-0700/74%	2000-0600/55%	2000-0600/57%
Subyearling Chinook	2000-0400/58%	2000-0600/43%	1900-0700/74%	2000-0600/55%	2000-0600/57%
Steelhead	2000-0400/56%	2000-0600/43%	1900-0700/74%	2000-0600/55%	2000-0600/57%

[6] Fish spill efficiency: y = percent fish spilled; x = percent river spilled (instantaneous)

D. ELEMENTS OF GENETIC RISK ANALYSES

An integral part of subbasin planning is analysis of the genetic risks entailed by proposed production strategies. (Genetic risks associated with harvest and passage actions are not discussed here.) In section 204 of the Draft Amendment Document, it is proposed that subbasin plans include consideration of potential effects on wild or naturally-spawning runs and identification of genetics-based management opportunities. Although it is not possible to quantify genetic risks, it is possible to identify the most likely sources of risk, the rationale for accepting the risk in preference to less risky alternatives, and to propose ways of managing genetic risks. Genetic risk analyses would be prepared by subbasin production planners.

The genetic risk analyses would include the following elements:

1. Description of the proposed production strategy. A production strategy identifies how fish would be produced, including use of wild/natural production , use of hatcheries, hatchery management plans (e.g., source of broodstock), etc.

2. Identification of the sources of risk and their relative magnitude.

Sources of risk would include impacts on wild/natural stocks. Protecting wild stocks would be a low-risk action, while releasing large numbers of hatchery smolts into a wild stream would be a high-risk action. (For example, see the scheme for evaluating genetic risks included in the Council's technical discussion paper, "Genetic Considerations for Salmon and Steelhead Planning," May 1986.) The genetic nature of the wild/ natural stock, as well as the genetic nature of possible hatchery stock genetic "donors" and the likelihood of interbreeding between wild/natural and hatchery stocks are important factors. Other risks to wild/natural stocks, such as competition between wild/ natural and hatchery smolts and removal of wild adults for hatchery broodstock, also need to be considered.

Sources of risk also include the plans for managing any artificial production, such as the source of broodstock (the specific run, numbers of males and females, and the segment of the run to be selected) and the rearing of juveniles.

General production approaches involving low, moderate and high risk follow: (See System Objective and Policies issue paper for background on genetic risks.)

A. Low-risk approach. Only wild/ natural stocks: no artificial production. This entails the least risk, because:

   1. Wild/natural s tocks tend to be more adaptable to changing environmental conditions (both natural and human-caused) than stocks managed for artificial production.

   2. Preserving wild/natural stocks does not foreclose future management options, because a wide variety of stocks is available to meet future needs.

   3. Wild/ natural stocks survive better in the wild and have better disease resistance. This is because genetic traits needed for survival and disease resistance have not been lost as a result of intentional or unintentional breeding and selection for artificial production.

B. Moderate risk approaches. Limited and genetically careful use of artificial production. The following actions entail moderate genetic risk:

1. Broodstock for hatchery production. Maximize retention of important genetic traits by:

    a. Using local wild/natural broodstock for each brood year

    b. Using large numbers of males and females for broodstock

    c. Using fish for broodstock having varying run times and other characteristics

2. Disposition of juveniles. Maximize opportunity for natural selection and minimize opportunity for artificial selection to act upon juvenile fish by:

    a. Releasing juveniles from the hatchery as early as is feasible

    b. Varying the time of release consistent with the range of the natural migratory period

    c. Outplanting juveniles in a variety of appropriate locations rather than in a single location

3. Protection of wild/natural stocks. Minimize "dilution" of wild/natural gene pools by:

    a. Minimizing interbreeding of wild and hatchery fish

    b. When supplementation is desired.

        i. Using outplants originating from wild/natural parents of the same stock

        ii. Controlling the ratio of outplants to naturally-reared fish

        iii. Monitoring the genetic characteristics of the supplemented stock

4. Other factors. Maximize ability to learn while undertaking some risk by:

    a. Taking action at a slow enough rate that risk is minimized and learning can occur

    b. Taking action in a limited number of locations and involving limited numbers of fish, so that the risk is not applied extensively

    c. Providing for learning, through monitoring and evaluation of genetic characteristics to identify occurrence of significant genetic effects

C. High-risk approaches: Extensive, rapid and genetically disinterested use of artificial production.

1. Broodstock are selected without regard for genetic diversity. Hatchery returns and few parents of unequal sex ratio may be used.

2. Decisions on disposition of juveniles, such as time and location of release, are made without regard for natural selection.

3. Protection of wild/natural gene pools from "dilution" is not attempted, is attempted to only a limited extent, or is attempted solely through techniques whose reliability is not proven.

4. Actions that may have genetic implications are undertaken extensively and at a rate that does not allow learning. Monitoring and evaluation of genetic characteristics are not a priority or do not receive sustained, stable funding over significant periods of time.

3. Alternative production strategies. One or two alternative production strategies that were proposed as part of subbasin planning but were considered less desirable than the preferred strategy.

4. Advantages of the preferred strategy. What are the advantages of undertaking the preferred strategy in preference to less risky alternatives (if less risky alternatives have been identified).

5. Monitoring and evaluation plan for identification of genetic impacts. How would genetic changes in the population be measures? What sampling strategies would be used? What criteria would be used to denote adverse genetic impacts?

6. Contingency plans in the event of adverse genetic impacts. Once adverse genetic impacts are identified. what strategies would be adopted to halt or reverse the impacts?

REFERENCES CITED

Bjornn, T. C. 1978. Survival, production and yield of trout and chinook salmon in the Lemhi River, Idaho. Bulletin 27 College of Forestry, Wildlife, and Range Sciences. University of Idaho, Moscow, Idaho.

Bouck, G. 1986. (Draft) Proposed Plans for Qualitatively and Quantitatively Improving Artificial Propagation of Anadromous Salmonids in the Columbia River Basin, Action Item 34.23 of the Columbia River Basin Fish and Wildlife Program, Bonneville Power Administration, Portland, Oregon.

Corps of Engineers. 1985. Lower Snake River Compensation Plan, Special Report to Congress, May 1985.

Ebel, W. J., G. K. Tanonaka, G. E. Monan, H. L. Raymond, and D. L. Park, 1979. Status Report--1978; The Snake River salmon and steelhead crisis: Its relation to dams and the national energy shortage. NWAFC Processed Report 79-9. National Marine Fisheries Service, Seattle, WA.

Envirosphere. 1986. Estimates of juvenile and adult salmon and steelhead trout production in the Columbia River Basin.

GAIA. 1985. Survey of Artificial Production of Anadromous Salmonids in the Columbia River Basin, Final Report 1985, Percy Washington editor, Bonneville Power Administration Project 84-51. November 25, 1985, Portland, Oregon.

Howell, P., K. Jones, D. Scarnecchia, L. LaVoy, W. Kendra and D. Ortman. 1985. Stock Assessment of Columbia River Salmonids. Bonneville Power Admin. Contract No. DE-AI79-84BP12737, Project 83-335.

Jonasson, B. and R. Lindsay. 1983. An ecological and fish cultural study of Deschutes River salmonids, Oregon Department of Fish and Wildlife, Fish Res. Proj. F-88-R-13. Annual Progress Report, Portland, Oregon.

Knox, W., M. Flesher, B. Lindsay, and L. Lutz. 1984. Spring chinook studies in the John Day River. Oregon Dept. of Fish and Wildlife, Fish Research Proj. DE-AC79-84BP39796, Annual Progress Report, Portland, Oregon.

Major, R. L. and J. L. Mighell. 1969. Egg-to-migrant survival of spring chinook salmon (Oncorhynchus tshawytscha) on the Yakima River, Washington Fishery Bull. 67:347-359.

Northwest Power Planning Council. 1984. Columbia River Basin Fish and Wildlife Program.

Northwest Power Planning Council. 1986a. Council Staff Compilation of Information on Salmon and Steelhead Losses in the Columbia River Basin. Draft Amendment Document, Technical Appendix 3.

Northwest Power Planning Council. 1986b. Columbia River Basin Fish and Wildlife Program: 1986 Draft Amendment Document (September 1, 1986).

Scribner, T. 1986. Proposed Yakima River Basin Central Outplanting Facility Production Profiles, Management Policies, and Release Sites, NWPPC, Portland, Oregon.

United States et al. versus State of Oregon et al. Civil No. 68-513 (D.Ore.)

United States Bureau of Reclamation-Washington Department of Ecology. 1985. Yakima River Basin Water Enhancement Project. Phase 2 Status Report (April 1985: revised December 1985).

Attachments (3).

Attachment 1.

DENSITY DATA BASE SUMMARY

One of the primary reasons for creating the Council's anadromous fish data base was to facilitate the generation of existing and potential smolt production estimates for the Columbia Basin.

The Council contracted with Envirosphere Company to assist in this process, which consisted of identifying the various methods currently in use by fish management agencies to estimate production, evaluate these methods for accuracy and data needs. and select and execute a method(s) for the area in question. Two conceptual groups of methods were identified by Envirosphere: 1) those based on densities of juveniles and 2) those based on escapement of adults. Based on a pilot study conducted in the Yakima Basin. Envirosphere suggested that escapement-based methods produced the most accurate results. because they relied on what was considered to be the most reliable data. Unfortunately, the data requirements for this type of analysis are quite specific and not widely available within the Columbia Basin. Therefore. the Council directed Envirosphere to use a habitat-based density method (smolt production per unit of available habitat). This method is less accurate than an escapement-based method but was the only method that could be applied consistently throughout the Columbia Basin. given the data constraints present in the area.

With the method chosen, Envirosphere developed existing and potential smolt density production estimates (smolts/square foot of habitat) for the Columbia Basin. These density estimates we re based on currently used habitat only and do not consider areas above permanent blockages. The density estimates are shown in Table 1. Density numbers appear as they would be applied in each particular basin but do not necessarily indicate that the species is present in the basin at this time. Those fall chinook fields marked with an (*) represent areas where an existing density estimate was back-calculated from current values on escapement and harvest.

TABLE 1.

DENSITY VALUES USED TO ESTIMATE EXISTING AND POTENTIAL SMOLT PRODUCTION VALUES FOR ANADROMOUS STREAMS

Abbreviations: Su = summer, Sp = spring, Wi = winter. LE = less than, GE = greater than or equal to, GT = greater than

WILLAMETTE RIVER (EXCLUDING CLACKAMAS)[1]

SPECIES	WIDTH	EXISTING	POTENTIAL
Su/Wi Steelhead	LE 33	0.0008/sq. ft.	0.0027/sq. ft.
	GT 33 LT 198	0.0008/sq. ft.	0.0015/sq. ft.
	GE 198	434/mile	406/mile
Fall Chinook	LE 330	0 0061/sq. ft.	0.0223/sq. ft.
	GT 330	10622/mile	38624/mile
Sp/Su Chinook	LE 66	0 0020/sq. ft.	0.0334/sq. ft.
	GT 66	676/mile	11587/mile
Coho	GT 20	0.0015/sq. ft.	0.0474/mile
	GE 20	515/mile	3726/mile

CLACKAMAS RIVER

SPECIES	WIDTH	EXISTING	POTENTIAL
Su/Wi Steelhead	LE 33	0.0008/sq. ft.	0.0027/sq. ft.
	GT 33 LT 198	0.0008/sq. ft.	0.0015/sq. ft.
	GE 198	434/mile	406/mile
Fall Chinook	LE 330	0.0061/sq. ft.	0 0223/sq. ft.
	GT 330	10622/mile	38624/mile
Sp/Su Chinook	LE 66	0.0020/sq. ft.	0.0334/sq. ft.
	GT 66	676/mile	11587/mile
Coho	GT 20	0.0065/sq. ft.	0.0474/mile
	GE 20	3291/mile	3726/mile

1/ The Clackamas basin was excluded from the Willamette because of differences in coho density estimates.

SANDY RIVER

SPECIES	WIDTH	EXISTING	POTENTIAL
Su/Wi Steelhead	LE 33	0.0022/sq. ft.	0.0027/sq. ft.
	GT 33 LT 198	0.0006/sq. ft.	0.0015/sq. ft.
	GE 198	290/mile	406/mile
Fall Chinook*	LE 330	0.0041/sq. ft.	0.0223/sq. ft.
	GT 330	0.0041/sq. ft.	38624/mile
Sp/Su Chinook	LE 66	0.0020/sq. ft.	0.0334/sq. ft.
	GT 66	676/mile	11587/mile
Coho	GT 20	0.0015/sq. ft.	0.0474/mile
	GE 20	515/mile	3726/mile

LEWIS RIVER

SPECIES	WIDTH	EXISTING	POTENTIAL
Su/Wi Steelhead	LE 33	0.0022/sq. ft.	0.0027/sq. ft.
	GT 33 LT 198	0.0006/sq. ft.	0.0015/sq. ft.
	GE 198	290/mile	406/mile
Fall Chinook*	LE 330	0.0057/sq. ft.	0.0223/sq. ft.
	GT 330	0.0057/sq. ft.	38624/mile
Sp/Su Chinook	LE 66	0.0020/sq. ft.	0.0334/sq. ft.
	GT 66	676/mile	11587/mile
Coho	GT 20	0.0015/sq. ft.	0.0474/mile
	GE 20	515/mile	3726/mile

COWLITZ RIVER

SPECIES	WIDTH	EXISTING	POTENTIAL
Su/Wi Steelhead	LE 33	0.0022/sq. ft.	0.0027/sq. ft.
	GT 33 LT 198	0 0006/sq. ft.	0.0015/sq. ft.
	GE 198	290/mile	406/mile
Fall Chinook*	LE 330	0 0082/sq. ft.	0.0223/sq. ft.
	GT 330	0.0082/sq. ft.	38624/mile
Sp/Su Chinook	LE 66	0 0020/sq. ft.	0.0334/sq. ft.
	GT 66	676/mile	11587/mile
Coho	GT 20	0.0015/sq. ft.	0.0474/mile
	GE 20	515/mile	3726/mile

GRAYS, ELOCHOMAN, KALAMA, & WASHOUGAL RIVERS[2]

SPECIES	WIDTH	EXISTING	POTENTIAL
Su/Wi Steelhead	LE 33	0.0022/sq. ft.	0.0027/sq. ft.
	GT 33 LT 198	0.0006/sq. ft.	0.0015/sq. ft.
	GE 198	290/mile	406/mile
Fall Chinook	LE 330	0.0061/sq. ft.	0.0223/sq. ft.
	GT 330	10622/mile	38624/mile
Sp/Su Chinook	LE 66	0.0020/sq. ft.	0.0334/sq. ft.
	GT 66	676/mile	11587/mile
Coho	GT 20	0.0015/sq. ft.	0.0474/mile
	GE 20	515/mile	3726/mile

2/ These basins were combined since the density estimates are the same.

WIND, BIG WHITE SALMON, HOOD, KLICKITAT
UMATILLA, & WALLA WALLA RIVERS[2]

SPECIES	WIDTH	EXISTING	POTENTIAL
Su/Wi Steelhead	LE 33	0.0030/sq. ft.	0.0027/sq. ft.
	GT 33 LT 198	0.0007/sq. ft.	0.0015/sq. ft.
	GE 198	386/mile	406/mile
Fall Chinook	LE 330	0.0002/sq. ft.	0.0223/sq. ft.
	GT 330	220/mile	38624/mile
Sp/Su Chinook	LE 66	0.0020/sq. ft.	0.0334/sq. ft.
	GT 66	676/mile	11587/mile
Coho	GT 20	0.0007/sq. ft.	0.0474/mile
	GE 20	257/mile	3726/mile

DESCHUTES RIVER

SPECIES	WIDTH	EXISTING	POTENTIAL
Su/Wi Steelhead	LE 33	0.0030/sq. ft.	0.0027/sq. ft.
	GT 33 LT 198	0.0007/sq. ft.	0.0015/sq. ft.
	GE 198	386/mile	406/mile
Fall Chinook*	LE 330	0.0080/sq. ft.	0.0223/sq. ft.
	GT 330	0.0080/mile	38624/mile
Sp/Su Chinook	LE 66	0.0020/sq. ft.	0.0334/sq. ft.
	GT 66	676/mile	11587/mile
Coho	GT 20	0.0007/sq. ft.	0.0474/mile
	GE 20	257/mile	3726/mile

JOHN DAY RIVER

SPECIES	WIDTH	EXISTING	POTENTIAL
Su/Wi Steelhead	LE 33	0.0030/sq. ft.	0.0027/sq. ft.
	GT 33 LT 198	0.0007/sq. ft.	0.0015/sq. ft.
	GE 198	386/mile	406/mile
Fall Chinook*	LE 330	0.0002/sq. ft.	0.0223/sq. ft.
	GT 330	0.0002/sq. ft.	38624/mile
Sp/Su Chinook	LE 66	0.0020/sq. ft.	0.0334/sq. ft.
	GT 66	676/mile	11587/mile
Coho	GT 20	0.0007/sq. ft.	0.0474/mile
	GE 20	257/mile	3726/mile

YAKIMA RIVER

SPECIES	WIDTH	EXISTING	POTENTIAL
Su/Wi Steelhead	LE 33	0.0004/sq. ft.	0.0027/sq. ft.
	GT 33 LT 198	0.0004/sq. ft.	0.0015/sq. ft.
	GE 198	415/mile	406/mile
Fall Chinook*	LE 330	0.0116/sq. ft.	0.0223/sq. ft.
	GT 330	0.0116/sq. ft.	38624/mile
Sp/Su Chinook	LE 66	0.0012/sq. ft.	0.0334/sq. ft.
	GT 66	1046/mile	11587/mile
Coho	GT 20	0.0007/sq. ft.	0.0474/mile
	GE 20	257/mile	3726/mile

OKANOGAN, ENTIAT, METHOW, HANFORD REACH & WENATCHEE RIVERS[3]

SPECIES	WIDTH	EXISTING	POTENTIAL
Su/Wi Steelhead	LE 33	0.0030/sq. ft.	0.0027/sq. ft.
	GT 33 LT 198	0.0007/sq. ft.	0.0015/sq. ft.
	GE 198	386/mile	406/mile
Fall Chinook*	LE 330	0.037/sq. ft.	0.0223/sq. ft.
	GT 330	0.037/sq. ft.	38624/mile
Sp/Su Chinook	LE 66	0.0023/sq. ft.	0.0334/sq. ft.
	GT 66	789/mile	11587/mile
Coho	GT 20	0.0007/sq. ft.	0.0474/mile
	GE 20	257/mile	3726/mile

GRANDE RONDE, TUCANNON, IMNAHA, SALMON, CLEARWATER, AND SNAKE RIVERS[3]

SPECIES	WIDTH	EXISTING	POTENTIAL
Su/Wi Steelhead	LE 33	0.0030/sq. ft.	0.0027/sq. ft.
	GT 33 LT 198	0.0007/sq. ft.	0.0015/sq. ft.
	GE 198	386/mile	406/mile
Fall Chinook	LE 330	0.0002/sq. ft.	0.0223/sq. ft..
	GT 330	220/mile	38624/mile
Sp/Su Chinook	LE 66	0.0067/sq. ft.	0.0334/sq. ft.
	GT 66	2317/mile	11587/mile
Coho	GT 20	0.0007/sq. ft.	0.0474/mile
	GE 20	257/mile	3726/mile

3/ These basins were combined since the density estimates are the same.

Attachment 2

Example of Fall Chinook
Computer-Generated
Production Estimates

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THESE ARE THE RESULTS FOR THE CLACKAMAS BASIN

FA_CHIN OCCUPY 16 STREAM MILES FOR THE 3RD ORFER ONLY
STREAMS IN THE BASIN
THE DOWNSTREAM SMOLT DAM MORTALITY IS 0.15
THE OCEAN MORTALITY IS 0.98
THE UPSTREAM ADULT DAM MORTALITY IS 0.05
THE PRE-MIGRATION EXISTING FA_CHIN SMOLT ESTIMATE IS: 91873
THE OCEAN ENTRY SMOLT ESTIMATE IS: 91873
THE SMOLT LOSS DUE TO DAMS IS: 0
THE ADULT ESTIMATE AT THE MOUTH IS: 1837
THE ADULT SPAWNING GROUND EST. IS: 1837
THE ADULT LOSS DUE TO DAMS IS: 0

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THESE ARE THE RESULTS FOR THE COWLITZ BASIN

FA_CHIN OCCUPY 52 STREAM MILES FOR THE 2ND ORDER ONLY
STREAMS IN THE BASIN
THE DOWNSTREAM SMOLT DAM MORTALITY IS 0.15
THE OCEAN MORTALITY IS 0.98
THE UPSTREAM ADULT DAM MORTALITY IS 0.05
THE PRE-MIGRATION EXISTING FA_CHIN SMOLT ESTIMATE IS: 718233
THE OCEAN ENTRY SMOLT ESTIMATE IS: 718233
THE SMOLT LOSS DUE TO DAMS IS: 0
THE ADULT ESTIMATE AT THE MOUTH IS: 14365
THE ADULT SPAWNING GROUND EST. IS: 14365
THE ADULT LOSS DUE TO DAMS IS: 0

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THESE ARE THE RESULTS FOR THE DESCHUTES BASIN

FA_CHIN OCCUPY 87 STREAM MILES FOR THE 2ND ORDER ONLY
STREAMS IN THE BASIN
THE DOWNSTREAM SMOLT DAM MORTALITY IS 0.15
THE OCEAN MORTALITY IS 0.98
THE UPSTREAM ADULT DAM MORTALITY IS 0.05
THE PRE-MIGRATION EXISTING FA_CHIN SMOLT ESTIMATE IS: 736928
THE OCEAN ENTRY SMOLT ESTIMATE IS: 626389
THE SMOLT LOSS DUE TO DAMS IS: 110539
THE ADULT ESTIMATE AT THE MOUTH IS: 12528
THE ADULT SPAWNING GROUND EST. IS: 11901
THE ADULT LOSS DUE TO DAMS IS: 626

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THESE ARE THE RESULTS FOR THE GRAYS BASIN

FA_CHIN OCCUPY 13 STREAM MILES FOR THE 2ND ORDER ONLY
STREAMS IN THE BASIN
THE DOWNSTREAM SMOLT DAM MORTALITY IS 0.15
THE OCEAN MORTALITY IS 0.98
THE UPSTREAM ADULT DAM MORTALITY IS 0.05

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THE PRE-MIGRATION EXISTING  FA_CHIN  SMOLT ESTIMATE IS:          13622
THE OCEAN ENTRY SMOLT ESTIMATE IS:          13622
THE SMOLT LOSS DUE TO DAMS IS:             0
THE ADULT ESTIMATE AT THE MOUTH IS:            272
THE ADULT SPAWNING GROUND EST. IS:           272
THE ADULT LOSS DUE TO DAMS IS:             0

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THESE ARE THE RESULTS FOR THE  HANFORD_REACH          BASIN

FA_CHIN  OCCUPY     71  STREAM MILES FOR THE  ALL STREAMS
  STREAMS IN THE BASIN
THE DOWNSTREAM SMOLT DAM MORTALITY IS    0.15
THE OCEAN MORTALITY IS    0.98
THE UPSTREAM ADULT DAM MORTALITY IS    0.05
THE PRE-MIGRATION EXISTING  FA_CHIN  SMOLT ESTIMATE IS:       20641894
THE OCEAN ENTRY SMOLT ESTIMATE IS:         10280326
THE SMOLT LOSS DUE TO DAMS IS:         10361568
THE ADULT ESTIMATE AT THE MOUTH IS:          205607
THE ADULT SPAWNING GROUND EST. IS:          165184
THE ADULT LOSS DUE TO DAMS IS:         40423

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THESE ARE THE RESULTS FOR THE  JOHN_DAY              BASIN

FA_CHIN  OCCUPY    181  STREAM MILES FOR THE  2ND ORDER AND ABOVE
  STREAMS IN THE BASIN
THE DOWNSTREAM SMOLT DAM MORTALITY IS    0.15
THE OCEAN MORTALITY IS    0.98
THE UPSTREAM ADULT DAM MORTALITY IS    0.05
THE PRE-MIGRATION EXISTING  FA_CHIN  SMOLT ESTIMATE IS:          18159
THE OCEAN ENTRY SMOLT ESTIMATE IS:          11152
THE SMOLT LOSS DUE TO DAMS IS:           7007
THE ADULT ESTIMATE AT THE MOUTH IS:            223
THE ADULT SPAWNING GROUND EST. IS:           191
THE ADULT LOSS DUE TO DAMS IS:            32

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THESE ARE THE RESULTS FOR THE  JOHN_DAY              BASIN

FA_CHIN  OCCUPY    181  STREAM MILES FOR THE  2ND ORDER ONLY
  STREAMS IN THE BASIN
THE DOWNSTREAM SMOLT DAM MORTALITY IS    0.15
THE OCEAN MORTALITY IS    0.98
THE UPSTREAM ADULT DAM MORTALITY IS    0.05
THE PRE-MIGRATION EXISTING  FA_CHIN  SMOLT ESTIMATE IS:          18159
THE OCEAN ENTRY SMOLT ESTIMATE IS:          11152
THE SMOLT LOSS DUE TO DAMS IS:           7007
THE ADULT ESTIMATE AT THE MOUTH IS:            223
THE ADULT SPAWNING GROUND EST. IS:           191
THE ADULT LOSS DUE TO DAMS IS:            32

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THESE ARE THE RESULTS FOR THE LEWIS BASIN

FA_CHIN OCCUPY 20 STREAM MILES FOR THE 2ND ORDER ONLY
STREAMS IN THE BASIN
THE DOWNSTREAM SMOLT DAM MORTALITY IS 0.15
THE OCEAN MORTALITY IS 0 98
THE UPSTREAM ADULT DAM MORTALITY IS 0.05
THE PRE-MIGRATION EXISTING FA_CHIN SMOLT ESTIMATE IS: 120986
THE OCEAN ENTRY SMOLT ESTIMATE IS: 120986
THE SMOLT LOSS DUE TO DAMS IS: 0
THE ADULT ESTIMATE AT THE MOUTH IS: 2420
THE ADULT SPAWNING GROUND EST. IS: 2420
THE ADULT LOSS DUE TO DAMS IS: 0

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THESE ARE THE RESULTS FOR THE SANDY BASIN

FA_CHIN OCCUPY 25 STREAM MILES FOR THE 2ND ORDER ONLY
STREAMS IN THE BASIN
THE DOWNSTREAM SMOLT DAM MORTALITY IS 0.15
THE OCEAN MORTALITY IS 0.98
THE UPSTREAM ADULT DAM MORTALITY IS 0.05
THE PRE-MIGRATION EXISTING FA_CHIN SMOLT ESTIMATE IS: 91006
THE OCEAN ENTRY SMOLT ESTIMATE IS: 91006
THE SMOLT LOSS DUE TO DAMS IS: 0
THE ADULT ESTIMATE AT THE MOUTH IS: 1820
THE ADULT SPAWNING GROUND EST. IS: 1820
THE ADULT LOSS DUE TO DAMS IS: 0

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THESE ARE THE RESULTS FOR THE WILLAMETTE BASIN

FA_CHIN OCCUPY 558 STREAM MILES FOR THE 2ND ORDER AND ABOVE
STREAMS IN THE BASIN
THE DOWNSTREAM SMOLT DAM MORTALITY IS 0.15
THE OCEAN MORTALITY IS 0.98
THE UPSTREAM ADULT DAM MORTALITY IS 0.05
THE PRE-MIGRATION EXISTING FA_CHIN SMOLT ESTIMATE IS: 2316406
THE OCEAN ENTRY SMOLT ESTIMATE IS: 2316406
THE SMOLT LOSS DUE TO DAMS IS: 0
THE ADULT ESTIMATE AT THE MOUTH IS: 46328
THE ADULT SPAWNING GROUND EST. IS: 46328
THE ADULT LOSS DUE TO DAMS IS: 0

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THESE ARE THE RESULTS FOR THE WILLAMETTE BASIN

FA_CHIN OCCUPY 215 STREAM MILES FOR THE 2ND ORDER ONLY
STREAMS IN THE BASIN
THE DOWNSTREAM SMOLT DAM MORTALITY IS 0.15
THE OCEAN MORTALITY IS 0.98
THE UPSTREAM ADULT DAM MORTALITY IS 0.05
THE PRE-MIGRATION EXISTING FA_CHIN SMOLT ESTIMATE IS: 1637394
THE OCEAN ENTRY SMOLT ESTIMATE IS: 1637394
THE SMOLT LOSS DUE TO DAMS IS: 0
THE ADULT ESTIMATE AT THE MOUTH IS: 32748

THE ADULT SPAWNING GROUND EST. IS: 32748
THE ADULT LOSS DUE TO DAMS IS: 0

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THESE ARE THE RESULTS FOR THE WILLAMETTE BASIN

FA_CHIN OCCUPY 197 STREAM MILES FOR THE 3RD ORFER ONLY
STREAMS IN THE BASIN
THE DOWNSTREAM SMOLT DAM MORTALITY IS 0.15
THE OCEAN MORTALITY IS 0.98
THE UPSTREAM ADULT DAM MORTALITY IS 0.05
THE PRE-MIGRATION EXISTING FA_CHIN SMOLT ESTIMATE IS: 418890
THE OCEAN ENTRY SMOLT ESTIMATE IS: 418890
THE SMOLT LOSS DUE TO DAMS IS: 0
THE ADULT ESTIMATE AT THE MOUTH IS: 8378
THE ADULT SPAWNING GROUND EST. IS: 8378
THE ADULT LOSS DUE TO DAMS IS: 0

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THESE ARE THE RESULTS FOR THE YAKIMA BASIN

FA_CHIN OCCUPY 32 STREAM MILES FOR THE 2ND ORDER ONLY
STREAMS IN THE BASIN
THE DOWNSTREAM SMOLT DAM MORTALITY IS 0.15
THE OCEAN MORTALITY IS 0.98
THE UPSTREAM ADULT DAM MORTALITY IS 0.05
THE PRE-MIGRATION EXISTING FA_CHIN SMOLT ESTIMATE IS: 737442
THE OCEAN ENTRY SMOLT ESTIMATE IS: 384949
THE SMOLT LOSS DUE TO DAMS IS: 352493
THE ADULT ESTIMATE AT THE MOUTH IS: 7699
THE ADULT SPAWNING GROUND EST. IS: 6271
THE ADULT LOSS DUE TO DAMS IS: 1428

* *

Attachment 3.

1. Description of Biologic Data Used in Fishery Planning Model

2. Generic and Basin Data File Listings for Fishery Planning Model

A DESCRIPTION OF BIOLOGIC DATA ON UPPER COLUMBIA RIVER NATURALLY PRODUCED SPRING CHINOOK STOCKS DEVELOPED FOR USE IN THE NORTHWEST POWER PLANNING COUNCIL'S FISHERY MODEL

September 30, 1986

prepared by

Phillip B. Roger

Columbia River Inter-Tribal Fish Commission

The fishery model developed by the Northwest Power Planning Council requires input data on the population structure of each stock of fish to be modelled. This report describes how these data were developed and some of the problems encountered during data assembly. Only occasionally were model input values reported directly in the available literature. Most of the time input values had to be calculated or estimated from various technical reports. Data from available reports was insufficient in some cases to develop input data sets, even though it is probable that sufficient data was collected and exists in an unreported form in someone's files.

Table 1 presents the basic information used to develop model input values. Each column is labelled as to whether data was input from a documented source or was calculated from input data. Original input data sources are listed in Table 2 and formulas used for calculations are given in Table 3. The model required each stock be described in terms of its present size (number of fish), initial age structure (number of fish in each ocean age class), and average fecundity per fish for each ocean age class. Recent total stock size and age structure was usually available, although sometimes not for the same years. Average female fecundity was sometimes reported but fecundity by age or size was almost never available and, therefore, had to be calculated.

Herewith are some observations on specific data elements in Table 1.

STOCK -

Snake River spring chinook exhibit a variety of population structures. Although Sawtooth and Rapid River are hatcheries, they probably adequately represent natural populations which are predominantly five and four years old, respectively.

PERCENT FEMALES BY AGE -

The percentage of each age class composed of females was never reported directly but could often be calculated from reported tables of length frequency, for instance. Other times the average percentage of females overall was reported. In these cases I assumed all 1-ocean fish were male and 2-ocean and 3-ocean fish had the same percentage of females.

AVERAGE FEMALE SIZE -

This parameter probably is the least accurate and has the greatest inconsistency between stocks. The type of length measurement, whether fork, hypural or total, was rarely reported and probably varied between stocks. If fork lengths were taken from spawned out carcasses, we should expect a large error because of tail erosion during spawning. The best that can be said is that the numbers reported are from observations on each stock, not extrapolated from another area.

AVERAGE FEMALE FECUNDITY -

Fecundity was calculated from an overall length-fecundity relationship for Columbia River chinook (Galbreath & Ridenhour 1964). This may obscure differences between stocks but was the only way to obtain fecundity by age. The total average female fecundity is a calculated value and was used as a cross check against reported average fecundity when available. These two values were usually within a few hundred eggs which indicates acceptable accuracy of this approach to developing model input values.

RECENT POPULATION SIZE -

Where possible, the recent 5-year average population size was input. This was not representative for the Yakima River where runs have been increasing rapidly in recent years. The value used for the Yakima (4000) is more nearly a recent median value rather than an average. Population size by age was calculated by multiplying the total population size by the percentage age composition.

able 1. Descriptive biologic data for five naturally produced spring chinook populations

(Power Council model input values 9/30/86)

Stock (ocean age)	Pop. age (%) (input)	Percent female (input)	Avg fem size(in) (input)	Avg fem fecund. (calc.)	Recent pop size (calc/inp)	Number females (calc.)	Total fecund.. (calc.)	Avg pop fecund. (calc.)
Sawtooth								
1	16.20	2.30	20.00	1967	389	9	17590	45
2	20.50	16.00	29.50	4200	492	79	330585	672
3	63.30	70.60	36.00	5727	1519	1073	6142524	4043
total	--	--	35.44	5594	2400	1160	6490698	2704
Rapid River								
1	10.70	.00	.00	0	482	0	0	0
2	70.70	56.30	28.50	3965	3182	1791	7101151	2232
3	18.60	56.30	33.20	5069	837	471	2388670	2854
total	--	--	29.48	4195	4500	2262	9489821	2109
Methow								
1	2.00	.00	.00	0	60	0	0	0
2	66.00	62.00	29.50	4200	1980	1228	5155306	2604
3	32.00	62.00	34.30	5328	960	595	3170928	3303
total	--	--	31.07	4568	3000	1823	8326234	2775
Grande Ronde								
1	10.00	.00	.00	0	100	0	0	0
2	67.00	63.00	27.20	3659	670	422	1544464	2305
3	23.00	81.00	31.90	4764	230	186	887440	3858
total	--	--	28.64	3997	1000	608	2431904	2432
Yakima								
1	11.40	20.00	21.10	2226	456	91	202966	445
2	76.20	51.20	28.80	4035	3048	1561	6296924	2066
3	12.30	57.90	36.20	5774	492	285	1644828	3343
total	--	--	29.53	4206	4000	1937	8144718	2036

Table 2. Description of data sources for five naturally produced spring chinook populations.

(Power Council model - documentation of data sources 9/30/86)

Stock (ocean age)	Pop. age (%) (input)	Percent female (input)	Avg fem size(in) (input)	Recent tot pop size (calc/inp)
Sawtooth				
1	IDFG 1981-85a	IDFG 1981-85a	IDFG 1981-85a	-----
2	1980-84	1980-84	1980-84	-----
3				-----
total	-----	-----	-----	SAS p365 2.4 fish/redd
Rapid River				
1	SAS p318 Table 2	IDFG 1981-85b	IDFG 1981-85b	-----
2		1980-84 avg	1983-85 combined	-----
3			used only CWT fish	-----
total	-----	-----	-----	SAS p319 77-81 avg
Methow				
1	Mullen, 1985	Mullen, 1985	Mullen, 1985	-----
2	as reported for	assume all 1's are male	sexes combined	-----
3	Winthrop hatchery	use pop ratio for 2, 3	from Winthrop hatchery	-----
total	-----	-----	-----	SAS: Mullen, 1985
Grande Ronde				
1	SAS p296 Table 6	Burck, 1969-72	Burck, 1969-72	-----
2		1968-71 avg	1968-71 avg	-----
3		from spawn survey	from spawn survey	-----
total	-----	-----	-----	SAS p291 Table 3
Yakima				
1	SAS p399 Table 5	SAS p400 Table 7	Hollowed, 1984	-----
2	Yakima wtd 0.66		1980-83 avg	-----
3	Naches wtd 0.34		sexes combined	-----
total	-----	-----	-----	SAS p396 80-84 avg; 1985-86 actual returns

SAS = Howell, et al. 1985.

Dashed lines indicate those values were calculated rather than input.

Table 3. Formulas used to derive calculated values shown in Table 1.

1. <u>Average fecundity per female, by ocean age</u> =

   (avg female size by age)(235) - 2733

2. <u>Recent population size, by age</u> =

   (avg recent tot pop)(% composition by age)

3. <u>Number of females, by age</u> =

   (recent pop size by age)(% female by age)

4. <u>Total fecundity, by age</u> =

   (No. females by age)(avg female fecundity by age)

5. <u>Average fecundity per fish, by age</u> =

   (tot fecundity by age)/(recent pop size by age)

6. <u>Average total female size</u> =

   Σ (avg size by age)(no. fem by age)/(tot females)

7. <u>Average total female fecundity</u> =

   (tot fecundity)/(tot no. females)

8. <u>Total number of females</u> =

   Σ (no. females by age)

9. <u>Total population fecundity</u> =

   Σ (tot fecundity by age)

10. <u>Total population fecundity per fish</u> =

    (tot pop fecundity)/(recent tot pop size)

LITERATURE CITED

Burck, W. A. 1969-72. Lookingglass Creek summary reports. Fishery Research Reports nos. 21, 29, 34, 36. Fish Commission of Oregon, Portland, Oregon.

Galbreath, J. L. and R. L. Ridenhour. 1964. Fecundity of Columbia River chinook salmon. Research Briefs 10(1):16-27. Fish Commission of Oregon.

Howell, P., K. Jones, D. Scarnecchia, L. LaVoy, W. Kendra, and D. Ortmann. 1985. Stock assessment of Columbia River anadromous salmonids, Volume I: chinook, coho, chum and sockeye salmon stock summaries. U. S. Dept. Energy, Bonneville Power Administration, Div. Fish and Wildlife, project 83-335.

IDFG. 1981-1985 a. Fish hatchery evaluations - Idaho. Lower Snake River compensation plan office. Idaho Dept. Fish and Game, Boise, Id.

IDFG. 1981-1985 b. Evaluation of spring chinook salmon emigration, harvest and returns to Rapid River Hatchery. Idaho Dept. Fish and Game, Boise, Id.

Mullen, J. W. 1985. Leavenworth Hatchery Complex spring chinook salmon escapement, 1985, and related information. U.S. Fish and Wldlf Serv. memorandum to John Miller dated 9/20/85, 7 pp.

File Name: GENFILE2

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Bypass Survival...........	7.0000	Spillway Survival..........	0.9800
Turbine Survival...........	0.8500	Transport Survival.........	0.8000
Rel. Mating Hatch X Wild...	0.8000	Rel. Mating Hatch X Hatch..	0.5000
Std Dev. Egg-Fry Surv......	0.2000	Min Flow for Max Res Surv..	265
Std Dev. Fry-Smolt Surv....	0.2000	Min Reservoir Surv Mult....	10
Min Hatch Failure Factor...	0.5000		

Ocean Age	Relative Vulnerability to Ocean Fishing
1	0.2000
2	0.7000
3	1.0000
4	1.0000

===

REMARKS / PURPOSE:

Scenario A GENFILE. Present (1986) passage conditions, spill equal to FISHPASS estimates of requirement for 90% per project survival. Harvest equal to zero.

For Scenario B simulations, same GENFILE was used except that reservoir survival, FGE, and proportion transported were manipulated to produce a range in survival rate.

File Name: GENFILE2

==

Species No................................ 1

Species Name.............................. SPRING CHINOOK
Estuary Harvest Rate...................... 0.00
Estuary and Early Ocean Survival.......... 0.10
Expl. Rate at Max Ocean Age............... 0.00
Ocean Survival Rate....................... 0.50
Initial Survival from Ocean to Spawning... 0.50

Ages	1	2	3	4
Fraction Fems:	0.00	0.50	0.50	0.50
Eggs per Fem:	0	4000	4000	4000

Inter-Species Competition Effect

Species 1	1.00
Species 2	0.00
Species 3	0.00
Species 4	0.00
Species 5	0.00
Species 6	0.00
Species 7	0.00

Species No................................ 2

Species Name.............................. BRIGHT FALL CHINOOK
Estuary Harvest Rate...................... 0.00
Estuary and Early Ocean Survival.......... 0.10
Expl. Rate at Max Ocean Age............... 0.00
Ocean Survival Rate....................... 0.50
Initial Survival from Ocean to Spawning... 0.40

Ages	1	2	3	4
Fraction Fems:	0.00	0.50	0.50	0.50
Eggs per Fem:	0	4000	6000	6000

Inter-Species Competition Effect

Species 1	0.00
Species 2	1.00
Species 3	0.00
Species 4	0.00
Species 5	0.00
Species 6	0.00
Species 7	0.00

File Name: GENFILE2

==

Species No............................... 3

Species Name............................. WELLS SUMMER CHINOOK
Estuary Harvest Rate..................... 0.00
Estuary and Early Ocean Survival......... 0.10
Expl. Rate at Max Ocean Age.............. 0.00
Ocean Survival Rate...................... 0.50
Initial Survival from Ocean to Spawning... 0.40

Ages	1	2	3	4
Fraction Fems:	0.00	0.50	0.50	0.50
Eggs per Fem:	0	4000	6000	6000

Inter-Species Competition Effect

Species 1	0.00
Species 2	0.00
Species 3	1.00
Species 4	0.00
Species 5	0.00
Species 6	0.00
Species 7	0.00

Species No............................... 4

Species Name............................. A+B SUMMER STEELHEAD
Estuary Harvest Rate..................... 0.00
Estuary and Early Ocean Survival......... 0.20
Expl. Rate at Max Ocean Age.............. 0.00
Ocean Survival Rate...................... 0.60
Initial Survival from Ocean to Spawning... 0.50

Ages	1	2	3	4
Fraction Fems:	0.50	0.50	0.50	0.00
Eggs per Fem:	4000	5000	7000	0

Inter-Species Competition Effect

Species 1	0.00
Species 2	0.00
Species 3	0.00
Species 4	1.00
Species 5	0.00
Species 6	0.00
Species 7	0.00

File Name: GENFILE2

Project No............................... 1

Project Name............................. BONNEVILLE
Proportion Spilled....................... 0.3900
Min. Res. Mort/Mile...................... 0.0020
Reservoir Length in miles................ 46

Species	FGE	River Harv. Rate	Upstream Survival	Prop Bypass Transported
1	0.5600	0.00	0.90	0.00
2	0.5600	0.00	0.95	0.00
3	0.5600	0.00	0.95	0.00
4	0.5600	0.00	0.95	0.00
5	0.0000	0.00	0.00	0.00
6	0.0000	0.00	0.00	0.00
7	0.0000	0.00	0.00	0.00

Next Project Downstream.................. 0

Project No............................... 2

Project Name............................. THE DALLES
Proportion Spilled....................... 0.0400
Min. Res. Mort/Mile...................... 0.0020
Reservoir Length in miles................ 24

Species	FGE	River Harv. Rate	Upstream Survival	Prop Bypass Transported
1	0.4400	0.00	0.90	0.00
2	0.4400	0.00	0.95	0.00
3	0.4400	0.00	0.95	0.00
4	0.4400	0.00	0.95	0.00
5	0.0000	0.00	0.00	0.00
6	0.0000	0.00	0.00	0.00
7	0.0000	0.00	0.00	0.00

Next Project Downstream.................. 1

File Name: GENFILE2

==

Project No............................... 3

Project Name............................. JOHN DAY
Proportion Spilled....................... 0.0400
Min. Res. Mort/Mile...................... 0.0020
Reservoir Length in miles................ 76

Species	FGE	River Harv. Rate	Upstream Survival	Prop Bypass Transported
1	0.7200	0.00	0.90	0.00
2	0.2000	0.00	0.95	0.00
3	0.2000	0.00	0.95	0.00
4	0.8500	0.00	0.95	0.00
5	0.0000	0.00	0.00	0.00
6	0.0000	0.00	0.00	0.00
7	0.0000	0.00	0.00	0.00

Next Project Downstream.................. 2

Project No............................... 4

Project Name............................. MCNARY
Proportion Spilled....................... 0.1100
Min. Res. Mort/Mile...................... 0.0020
Reservoir Length in miles................ 61

Species	FGE	River Harv. Rate	Upstream Survival	Prop Bypass Transported
1	0.7400	0.00	0.90	0.20
2	0.3800	0.00	0.95	0.00
3	0.3800	0.00	0.95	0.00
4	0.7600	0.00	0.95	0.00
5	0.0000	0.00	0.00	0.00
6	0.0000	0.00	0.00	0.00
7	0.0000	0.00	0.00	0.00

Next Project Downstream.................. 3

File Name: GENFILE2

==

Project No............................... 5

Project Name............................. ICE HARBOR
Proportion Spilled....................... 0.1100
Min. Res. Mort/Mile...................... 0.0020
Reservoir Length in miles................ 32

Species	FGE	River Harv. Rate	Upstream Survival	Prop Bypass Transported
1	0.5400	0.00	0.95	0.00
2	0.5400	0.00	0.95	0.00
3	0.5400	0.00	0.95	0.00
4	0.5400	0.00	0.95	0.00
5	0.0000	0.00	0.00	0.00
6	0.0000	0.00	0.00	0.00
7	0.0000	0.00	0.00	0.00

Next Project Downstream.................. 4

Project No............................... 6

Project Name............................. LOWER MONUMENTAL
Proportion Spilled....................... 0.2400
Min. Res. Mort/Mile...................... 0.0020
Reservoir Length in miles................ 29

Species	FGE	River Harv. Rate	Upstream Survival	Prop Bypass Transported
1	0.0300	0.00	0.95	0.00
2	0.0300	0.00	0.95	0.00
3	0.0300	0.00	0.95	0.00
4	0.0300	0.00	0.95	0.00
5	0.0000	0.00	0.00	0.00
6	0.0000	0.00	0.00	0.00
7	0.0000	0.00	0.00	0.00

Next Project Downstream.................. 5

File Name: GENFILE2

==

Project No.............................. 7

Project Name............................ LITTLE GOOSE
Proportion Spilled...................... 0.0300
Min. Res. Mort/Mile..................... 0.0020
Reservoir Length in miles............... 37

Species	FGE	River Harv. Rate	Upstream Survival	Prop Bypass Transported
1	0.5000	0.00	0.95	0.20
2	0.5000	0.00	0.95	0.00
3	0.5000	0.00	0.95	0.00
4	0.7400	0.00	0.95	0.00
5	0.0000	0.00	0.00	0.00
6	0.0000	0.00	0.00	0.00
7	0.0000	0.00	0.00	0.00

Next Project Downstream................. 6

Project No.............................. 8

Project Name............................ LOWER GRANITE
Proportion Spilled...................... 0.0300
Min. Res. Mort/Mile..................... 0.0020
Reservoir Length in miles............... 53

Species	FGE	River Harv. Rate	Upstream Survival	Prop Bypass Transported
1	0.5000	0.00	0.95	1.00
2	0.5000	0.00	0.95	0.00
3	0.5000	0.00	0.95	0.00
4	0.7400	0.00	0.95	0.00
5	0.0000	0.00	0.00	0.00
6	0.0000	0.00	0.00	0.00
7	0.0000	0.00	0.00	0.00

Next Project Downstream................. 7

File Name: GENFILE2

==

Project No.............................. 9

Project Name............................ PRIEST RAPIDS
Proportion Spilled...................... 0.1900
Min. Res. Mort/Mile..................... 0.0020
Reservoir Length in miles............... 18

Species	FGE	River Harv. Rate	Upstream Survival	Prop Bypass Transported
1	0.0000	0.00	0.95	0.00
2	0.0000	0.00	0.95	0.00
3	0.0000	0.00	0.95	0.00
4	0.0000	0.00	0.95	0.00
5	0.0000	0.00	0.00	0.00
6	0.0000	0.00	0.00	0.00
7	0.0000	0.00	0.00	0.00

Next Project Downstream.................. 4

Project No.............................. 10

Project Name............................ WANAPUM
Proportion Spilled...................... 0.2000
Min. Res. Mort/Mile..................... 0.0020
Reservoir Length in miles............... 38

Species	FGE	River Harv. Rate	Upstream Survival	Prop Bypass Transported
1	0.0000	0.00	0.95	0.00
2	0.0000	0.00	0.95	0.00
3	0.0000	0.00	0.95	0.00
4	0.0000	0.00	0.95	0.00
5	0.0000	0.00	0.00	0.00
6	0.0000	0.00	0.00	0.00
7	0.0000	0.00	0.00	0.00

Next Project Downstream.................. 9

File Name: GENFILE2

Project No.............................. 11

Project Name............................ ROCK ISLAND
Proportion Spilled...................... 0.1800
Min. Res. Mort/Mile..................... 0.0020
Reservoir Length in miles............... 21

Species	FGE	River Harv. Rate	Upstream Survival	Prop Bypass Transported
1	0.0000	0.00	0.95	0.00
2	0.0000	0.00	0.95	0.00
3	0.0000	0.00	0.95	0.00
4	0.0000	0.00	0.95	0.00
5	0.0000	0.00	0.00	0.00
6	0.0000	0.00	0.00	0.00
7	0.0000	0.00	0.00	0.00

Next Project Downstream................. 10

Project No.............................. 12

Project Name............................ ROCKY REACH
Proportion Spilled...................... 0.1000
Min. Res. Mort/Mile..................... 0.0020
Reservoir Length in miles............... 42

Species	FGE	River Harv. Rate	Upstream Survival	Prop Bypass Transported
1	0.0000	0.00	0.95	0.00
2	0.0000	0.00	0.95	0.00
3	0.0000	0.00	0.95	0.00
4	0.0000	0.00	0.95	0.00
5	0.0000	0.00	0.00	0.00
6	0.0000	0.00	0.00	0.00
7	0.0000	0.00	0.00	0.00

Next Project Downstream................. 11

File Name: GENFILE2

==

Project No............................... 13

Project Name............................. WELLS
Proportion Spilled....................... 0.3000
Min. Res. Mort/Mile...................... 0.0020
Reservoir Length in miles................ 29

Species	FGE	River Harv. Rate	Upstream Survival	Prop Bypass Transported
1	0.0000	0.00	0.95	0.00
2	0.0000	0.00	0.95	0.00
3	0.0000	0.00	0.95	0.00
4	0.0000	0.00	0.95	0.00
5	0.0000	0.00	0.00	0.00
6	0.0000	0.00	0.00	0.00
7	0.0000	0.00	0.00	0.00

Next Project Downstream.................. 12

Generic File Name: GENFILE1
Basin File Name: YAKIMA1

==

First Project Downstream....... MCNARY
Number of Stock................ 3
Egg-Fry Deviation.............. 0.2000
Fry-Smolt Deviation............ 0.2000
Hatchery Failure Factor........ 0.5000
Rel. Mating Hatch X Wild....... 0.8000
Rel. Mating Hatch X Hatch...... 0.5000

==

REMARKS / PURPOSE:

Yakima River Spring Chinook

Generic File Name: GENFILE1
Basin File Name: YAKIMA1

==

Species No................................ 1

Species Name.............................. SPRING CHINOOK

Natural Production Factors

Egg-Fry Survival..................	1.0000	
Fry-Smolt Survival................	0.2200	
Egg-Smolt Survival................	0.2200	(calculated)
Egg Capacity................	56000000	
Smolt Capacity..............	1670000	

Hatchery Production Factors

Egg-Fry Survival..................	1.0000	
Fry-Smolt Survival................	0.7200	
Egg-Smolt Survival................	0.7200	(calculated)
Egg Capacity................	135000	
Smolt Capacity..............	97000	
Hatchery Egg Take Policy.........	1	1=selective, 0=random
Max Wild Spawners Taken..........	0.2000	

Generic File Name: GENFILE1
Basin File Name: YAKIMA1

Stock No....... 1
Species........ SPRING CHINOOK
Natural/Hatch.. 1 (1=Natural,2=Fry Plant,3=Smolt Plant)

Terminal Harvest Rate............... 0.00

Initial Adult Escapement

Ocean Age	Number	Fraction Females	Eggs Per Female
1	457	0.20	2226
2	3050	0.51	4035
3	285	0.58	5774
4	0	0.00	0

Stock No....... 3
Species........ SPRING CHINOOK
Natural/Hatch.. 3 (1=Natural,2=Fry Plant,3=Smolt Plant)

Terminal Harvest Rate............... 0.00

Initial Adult Escapement

Ocean Age	Number	Fraction Females	Eggs Per Female
1	114	0.20	2226
2	762	0.51	4035
3	123	0.58	5774
4	0	0.00	0

Generic File Name: GENFILE1
Basin File Name: METHOW1

==

First Project Downstream....... WELLS
Number of Stock................ 3
Egg-Fry Deviation.............. 0.2000
Fry-Smolt Deviation............ 0.2000
Hatchery Failure Factor........ 0.5000
Rel. Mating Hatch X Wild....... 0.8000
Rel. Mating Hatch X Hatch...... 0.5000

==

REMARKS / PURPOSE:

Methow River Spring Chinook

Generic File Name: GENFILE1
Basin File Name: METHOW1

==

Species No.............................. 1

Species Name............................ SPRING CHINOOK

Natural Production Factors

Egg-Fry Survival..................	1.0000	
Fry-Smolt Survival................	0.2200	
Egg-Smolt Survival................	0.2200	(calculated)
Egg Capacity................	14600000	
Smolt Capacity..............	440000	

Hatchery Production Factors

Egg-Fry Survival..................	1.0000	
Fry-Smolt Survival................	0.7200	
Egg-Smolt Survival................	0.7200	(calculated)
Egg Capacity................	1667000	
Smolt Capacity..............	1333000	
Hatchery Egg Take Policy.........	1	1=selective, 0=random
Max Wild Spawners Taken..........	0.2000	

Generic File Name: GENFILE1
Basin File Name: METHOW1

Stock No....... 1
Species........ SPRING CHINOOK
Natural/Hatch.. 1 (1=Natural,2=Fry Plant,3=Smolt Plant)

Terminal Harvest Rate............... 0.00

Initial Adult Escapement .

Ocean Age	Number	Fraction Females	Eggs Per Female
1	20	0.00	0
2	660	0.62	4200
3	320	0.62	5328
4	0	0.00	0

Stock No....... 3
Species........ SPRING CHINOOK
Natural/Hatch.. 3 (1=Natural,2=Fry Plant,3=Smolt Plant)

Terminal Harvest Rate............... 0.00

Initial Adult Escapement

Ocean Age	Number	Fraction Females	Eggs Per Female
1	30	0.62	2178
2	990	0.62	4200
3	480	0.62	5328
4	0	0.00	0

Generic File Name: GENFILE1
Basin File Name: GRNDRND1

First Project Downstream....... LOWER GRANITE
Number of Stock................ 3
Egg-Fry Deviation.............. 0.2000
Fry-Smolt Deviation............ 0.2000
Hatchery Failure Factor........ 0.5000
Rel. Mating Hatch X Wild....... 0.8000
Rel. Mating Hatch X Hatch...... 0.5000

REMARKS / PURPOSE:

Grande Ronde River Spring Chinook

Generic File Name: GENFILE1
Basin File Name: GRNDRND1

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Species No............................... 1

Species Name............................. SPRING CHINOOK

Natural Production Factors

Egg-Fry Survival.................	1.0000	
Fry-Smolt Survival...............	0.2200	
Egg-Smolt Survival...............	0.2200	(calculated)
Egg Capacity................	15000000	
Smolt Capacity..............	450000	

Hatchery Production Factors

Egg-Fry Survival.................	1.0000	
Fry-Smolt Survival...............	0.7200	
Egg-Smolt Survival...............	0.7200	(calculated)
Egg Capacity................	1250000	
Smolt Capacity..............	1000000	
Hatchery Egg Take Policy.........	1	1=selective, 0=random
Max Wild Spawners Taken..........	0.2000	

Generic File Name: GENFILE1
Basin File Name: GRNDRND1

Stock No....... 1
Species........ SPRING CHINOOK
Natural/Hatch.. 1 (1=Natural,2=Fry Plant,3=Smolt Plant)

Terminal Harvest Rate............... 0.00

Initial Adult Escapement

Ocean Age	Number	Fraction Females	Eggs Per Female
1	100	0.00	0
2	670	0.63	3659
3	230	0.81	4764
4	0	0.00	0

Stock No....... 3
Species........ SPRING CHINOOK
Natural/Hatch.. 3 (1=Natural,2=Fry Plant,3=Smolt Plant)

Terminal Harvest Rate............... 0.00

Initial Adult Escapement

Ocean Age	Number	Fraction Females	Eggs Per Female
1	100	0.00	0
2	670	0.63	3659
3	230	0.81	4764
4	0	0.00	0