FINAL DRAFT

Exhibit B.3.b
OCN Work Group Report
November 2000

2000 REVIEW OF AMENDMENT 13 TO THE PACIFIC COAST SALMON PLAN

OCN WORK GROUP
Sam Sharr, ODFW
Curt Melcher, ODFW
Tom Nickelson, ODFW
Dr. Pete Lawson, NMFS
Dr. Robert Kope, NMFS
Dr. John Coon, PFMC

October 12, 2000

TABLE OF CONTENTS

FINAL DRAFT

LIST OF TABLES

FINAL DRAFT

LIST OF FIGURES

Figure | Page

FINAL DRAFT

LIST OF APPENDICES

FINAL DRAFT

EXECUTIVE SUMMARY

Amendment 13 to the Pacific Fishery Management Council (PFMC) Fishery Management Plan (FMP) was designed to insure that fishery related impacts do not act as a significant impediment to the recovery of depressed Oregon Coastal Natural (OCN) coho stocks. When the PFMC adopted the amendment in November 1997, they stipulated that it should be reviewed and updated on a periodic basis. With respect to the review, they specifically referenced technical concerns raised by the Scientific and Statistical Committee (SSC) and the Salmon Technical Team (STT) regarding parameters in the management matrix that trigger allowable fishery impacts. In their November 1999 meeting, the PFMC approved an Oregon Department of Fish and Wildlife (ODFW) proposal to form an ad hoc OCN work group composed of representatives from ODFW, PFMC, and National Marine Fisheries Service to complete the stipulated 2000 review.

In the last decade OCN coho spawner abundance has been low, the progeny from those spawners have experienced extremely low marine survival, and the last three brood cycles have failed to replace themselves. Because similar spawner abundance and marine survival conditions were expected to continue in the near future, the OCN work group focused the majority of their attention on management trigger points for conditions of low spawner abundance and marine survival. The group has met five times since their inception and, at the September 11-16, 2000 meeting of the PFMC, they presented a draft report of their findings to the SSC and the Council.

The draft report of the OCN work group contains an expanded management matrix that includes two new parental spawner categories and one new marine survival category. Hence, what was formerly a 3x3 matrix is now a 4x5 matrix. The new parental spawner categories occur in the low end of the spawner abundance range and are designated as "Very Low" and "Critical". The new marine survival category, designated as "Extremely Low", is also in the low end of the range and corresponds to levels observed from 1992 through 1998. In addition to the inclusion of new marine survival categories, there has also been a shift in the boundary between the "Low" and "Medium" categories.

The sensitivity of OCN coho productivity was examined for conditions of variable spawner abundance and protracted "Extremely Low" marine survival. Model results predict that **any** impacts that result in reductions in OCN spawner densities below a "Critical" level of four fish-per-mile significantly increase risk of extinction for the population. They also indicate that when the marine survival index is "Extremely Low" (hatchery jack to smolt ratio $\leq$ 0.0008), fishery related impacts in excess of 8% are likely to significantly impede recovery of the population

Fishery impact rates less than 8% are lower than any previously set by the PFMC in the preseason process. Reducing fishery impacts to this low level would require additional constraints on chinook directed and coho selective fisheries and would likely also require extensive PFMC negotiations with respect to the allocation of available fisheries resources among user groups.

FINAL DRAFT

INTRODUCTION

Oregon Coastal Natural (OCN) coho are an aggregate of naturally produced coho stocks from Oregon coastal streams (Figure 1). Historically this aggregate was the largest contributor of naturally produced coho caught in ocean fisheries off Oregon and California. OCN coho are also part of an even larger aggregate of natural and hatchery production south of Leadbetter Point, Washington known as the Oregon Production Index (OPI). Because of their relative importance, OCN coho abundance has a significant role in setting allowable harvest levels in fisheries in the OPI area, particularly in fisheries south of Cape Falcon, Oregon.

OCN coho spawning escapements were severely depressed in the late 1970's and a schedule to rebuild OCN coho stocks by 1987 was part of the original Pacific Fishery Management Council (PFMC) Fishery Management Plan (FMP) and the subsequent 1984 Framework Amendment. The rebuilding program for OCN coho was predicated upon managing fisheries for a long-term average Maximum Sustainable Yield (MSY) escapement goal of 200,000 spawners. Under this regime the total harvest of OCN coho in all fisheries was determined as the pre-season abundance forecast minus the desired MSY escapement of 200,000. Management success was contingent upon the correct assessment of MSY escapement and the accuracy of the pre-season forecast.

In 1986, a pre-season forecasting model based upon jack abundance in the previous year for OPI coho predicted a very large return. Unfortunately, managers in the PFMC were skeptical of the forecast, and opted to constrain fisheries based upon an another less optimistic prediction. Consistent with the initial forecast and contrary to the expectation of the PFMC, the return of the Columbia River hatchery component of the OPI was one of the largest ever recorded. Because the PFMC was poorly equipped to respond rapidly to forecast error, ocean fisheries never had an opportunity to access the large surplus of fish. More than 1.5 million coho escaped the ocean fisheries in 1986 and entered the Columbia River. This economic loss prompted the ocean salmon fishing industry to petition the Council for a modification of the fixed MSY escapement goal policy. The concern was that management in the wake of some future forecasts similar to such as occurred in 1986 might preclude or severely restrict fisheries again in the future even though hatchery stocks might be present in sufficient numbers to support a harvest. In response to this concern, the Council adopted Amendment 7 to the FMP in 1987.

Amendment 7 allowed for a deviation from the fixed goal of 200,000 spawners at forecasted OCN abundance levels below 400,000. The Council's analysis of management under Amendment 7 indicated that the strategy of reducing escapement goals in response to low abundance would result in increased economic benefits. It also projected that despite reductions in harvest constraints, spawning escapement shortfalls would be infrequent and would have a low likelihood of jeopardizing continued productivity of the OCN stock aggregate. The Council's analysis was predicated upon the assumption that large deviations from average productivity of the OCN stock such as occurred in 1983 are infrequent. However, under Amendment 7, OCN productivity continued to decline, the escapement goal was set below the 200,000 MSY goal in five of the nine years from 1985 through 1993 and the MSY goals were never met.

Based upon the persistent declining trend in OCN abundance and productivity, the PFMC took emergency action to reduce the harvest rates on OCN coho in 1991, 1992, and 1993. The Council also completed a stock status review of OCN coho in 1992. The review concluded that the decline of OCN coho could be attributed to widespread degradation and under-seeding of freshwater habitat, a long-term trend of poor ocean rearing conditions, and excessive harvest associated with over-estimation of OCN stock abundance.

By 1993 it was clear that management provisions in Amendment 7 frequently resulted in spawning escapement goals below those required for MSY, and consequently resulted in repeated failure to achieve MSY escapement. To address these failures the Council considered other management alternatives and in late 1993 adopted Amendment 11 to the FMP. Amendment 11 re-instituted a fixed MSY escapement goal for OCN coho, it restated the goal as 42 fish per mile, and it stipulated that when the pre-fishery population size dropped below 250,000, impacts from fisheries should not exceed 20% of the pre-fishery population. It further stipulated that, if the spawner densities dropped below 28 adults per mile, incidental fishery impacts would be allowed up to 20% only if they caused no irreparable harm to the OCN stock.

Despite the fixed MSY escapement goal and harvest constraints imposed by Amendment 11, OCN stocks failed to exhibit signs of recovery. By 1993 the National Marine Fisheries Service (NMFS) had already begun to receive petitions to list Oregon coastal coho populations as threatened under the Federal Endangered Species Act (ESA). In 1995 NMFS proposed coho populations in both the Oregon Coastal and Southern Oregon/ Northern California evolutionarily significant units (ESU's) for listing. In an attempt to restore OCN coho and avert the proposed ESA listings the state of Oregon initiated the Governor's Coastal Salmon Restoration Initiative (Oregon Plan). Concurrently the PFMC began to consider another amendment to their FMP that would insure that fishery related impacts would not act as a significant impediment to the recovery of depressed OCN coho stocks. The harvest management portion of the Oregon Plan formed the basis for changes in Council management of ocean fisheries and became the template for Amendment 13.

Unlike Amendment 11, Amendment 13 proposed managing fisheries based upon exploitation rates, not spawner escapement objectives. These exploitation rates are based upon estimates of habitat production potential that incorporate effects of both freshwater and marine environments and are derived from habitat-based assessment and modeling of OCN coho production. Amendment 13 also divides the coastwide aggregate of OCN coho stocks into smaller sub-aggregates based upon geographic proximity and genetic similarities among contributing populations (Figure 1). This approach addresses differences in production potential between populations in different basins. Furthermore, whereas management actions in Amendment 11 relied upon pre-season projections of

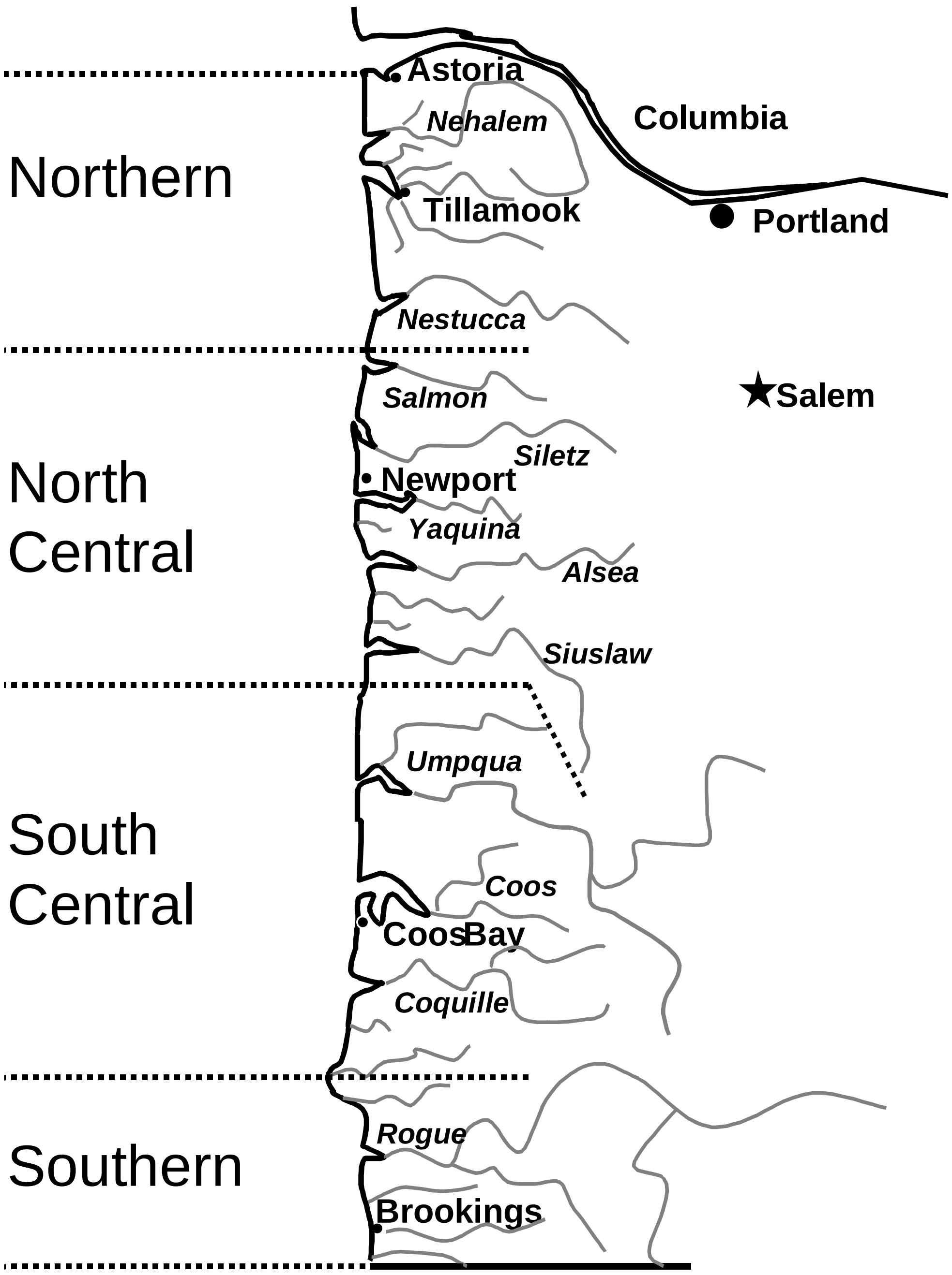

Figure 1. Map of the Oregon Coast showing major river basins that produce OCN coho and the sub-aggregate grouping of those basins.

abundance from inaccurate forecasting models, management actions in Amendment 13 are triggered by actual brood year specific parental spawner abundance and juvenile survival observations (Table 1). The Pacific Fishery Management Council approved Amendment 13 to the FMP in November 1997 (PFMC 1999).

Large-scale habitat and fisheries monitoring programs are principal components of the Oregon Plan. Results of these programs improve the accuracy and precision of data and assumptions used in habitat based production models. The PFMC recognized this dynamic nature of population projections based upon habitat based production models. They stipulated that Plan Amendment 13 should be reviewed and updated on a periodic basis to incorporate new information and that the first review will be completed in the year 2000.

The first reference to a review occurs in the overview section of the Council adopted management alternative (Section 2.2.1). It stipulates that the review must be comprehensive and adaptive. The reference in this section also contains a provision for Council approved changes to methods used to estimate technical parameters in the alternative without plan amendment provided that the proposed changes are reviewed and recommended by the Scientific and Statistical Committee. The purpose of this provision was to facilitate the timely incorporation of the best available science into the management process.

The second reference to a review in Council adopted management alternative occurs in Section 2.2.3 (Monitoring and Evaluation). It stipulates that a comprehensive evaluation mechanism will be implemented on a pre-determined schedule in the year 2000. It further stipulates that the review will be completed as a cooperative effort among co-managers in the PFMC process and that all features of the management alternative are subject to change upon completion of the scheduled review. Finally, it stipulates that the review will include but not be limited to evaluations of: 1) the relationship of parents to adult recruits at various life stages; 2) results of juvenile monitoring such as estimates of egg to fingerling to smolt survival, summer and winter carrying capacities, and stock specific parents to smolt relationships; 3) the relationship of fishery impacts on stock sustainability at various freshwater and marine survival rates; 4) stratified estimates of fishery related mortality; 5) parental spawner and marine survival levels that define decision points in the management matrix; 6) updated run reconstructions based on new Stratified Random Survey (SRS) methods for assessing spawners abundance and assessments of fisheries impacts based on post-season runs of the Fisheries Regulatory Assessment Model (FRAM); and 7) SRS related assumptions about viable spawning habitat.

The third reference to a performance review of Plan Amendment 13 occurs in Section 4.3 (Council Response to Technical Concerns). Council language in this section acknowledges that the new management approach in the Amendment must be adaptive and that a full review of the approach must occur in 2000. Technical concerns raised by the SSC and STT regarding parameters in the management matrix that trigger allowable fishery impacts were specifically emphasized. In that regard, the Council specifically

Table 1. Current Amendment 13 harvest management matrix with parental spawner and marine survival categories and associated fishery harvest impact rates for OCN coho.

PARENT SPAWNER STATUS [b/]	SMOLT TO ADULT MARINE SURVIVAL [a/]		
	Low	**Medium**	**High**
	ALLOWABLE TOTAL FISHERY IMPACT		
High Parent Spawners achieved Level #2 rebuilding criteria *and* grandparent spawners achieved Level #1 rebuilding criteria	**≤15%**	**≤30%**	**≤35%**
Medium Parent spawners achieved Level #1 or greater rebuilding criteria	**≤15%**	**≤20%**	**≤25%**
Low Parent spawners less than Level #1 rebuilding criteria	**≤15%** ----------------- **≤10-13%** [c/]	**≤15%**	**≤15%**

Stock Component Rebuilding Criteria:	**Level #1** (50%)	**Level #2** (75%)
Northern	10,900	16,400
North - Central	27,500	41,300
South - Central	25,000	37,500
Southern	2,700	4,100
Total	66,100	99,300

a/ Smolt to adult marine survival is projected from smolt to jack marine survival for representive OPI hatchery stocks from the appropriate brood year. Low medium and high marine survival categores are defined as less than 0.09%, from 0.09% to 0.34% and greater than = 0.34% respectively.

b/ In the event that a spawner criteria is achieved, but a *major* basin within the stock component is *less than ten percent of the full seeding level* , the next tier of additional harvest would not be allowed in mixed stock fisheries for that component, nor additional impacts within that particular basin. (see Table A-3 in Appendix A of Amendment 13 to the FMP for a listing of major basins within stock components and Table A-2 in Appendix A of Amendment 13 for spawners needed for full seeding at 3% marine survival.

c/ This exploitation rate criteria applies when parent spawners are less than 38% of the Level #1 rebuilding criteria, or *when marine survival conditions are extremely low as in 1994-98 (i.e. < 0.06% hatchery smolt to jack survival)* recommended that the review include special emphasis on the assessment of (1) how well the amendment provides for significant rebuilding towards full seeding and (2) a detailed review of the selection of parental spawner and marine survival criteria that trigger allowable impact rates in fisheries.

In the November 1999 meeting of the PFMC, the Oregon Department of Fish and Wildlife (ODFW) proposed the formation of an ad hoc OCN work group to complete the stipulated 2000 review. The proposed group would included representatives from ODFW, the PFMC staff, the Scientific and Statistical Committee (SSC), the Salmon Technical Team (STT) and an ODFW or WDFW representative on the Oregon Production Index Technical Team (OPITT) with ODFW as the lead agency. In recognition of their scientific expertise and oversight role with respect to the Oregon Plan, ODFW recommended that representatives from Oregon's Governor appointed Independent Multidisciplinary Science Team (IMST) be asked to attend all meetings of the OCN work group in an advisory capacity. ODFW also proposed a meeting and work schedule for the group that culminates with a final report for SSC and full Council review in November of 2000 (Appendix 1).

The Council approved the ODFW proposal in the November 1999 meeting and directed Dr. J. Coon of PFMC, Dr. R. Kope of NMFS, and Dr. P. Lawson of NMFS to be the representatives from the PFMC staff, the STT and the SSC respectively. ODFW subsequently appointed their Ocean Salmon Manager, S. Sharr, as their staff representative, C. Melcher, as their representative from OPITT (and the STT), and T. Nickelson (co-author of Amendment 13 and the subsequent risk assessment). ODFW also proposed a meeting and work schedule for the team that culminated in a final report for SSC and full Council review in November of 2000. The ad hoc review team has had five meetings since their inception in November 1999. Dates and attendance lists for the meetings are shown in Appendix 2.

GOALS AND OBJECTIVES

Two technical concerns that the SSC and STT explicitly identified as review items in Section 4.3 were: (1) how well the amendment provides for significant rebuilding towards full seeding and (2) a detailed review of the selection of parental spawner and marine survival criteria that trigger allowable impact rates in fisheries. Similarly, the IMST (1999) has identified the need for (1) explicit recovery criteria and (2) explicit links between biologically based production models for OCN coho and the parental spawner and marine survival criteria used as trigger points in the harvest management matrix of Plan Amendment 13. In addition during the early stages of their deliberations, the OCN Work Group recognized the need for more specific exploitation rate guidelines that minimize fishery impacts on OCN coho when stock size is extremely low and marine survival is very poor. The National Marine Fisheries Service (NMFS) has subsequently expressed similar interest in more specific guidelines for the "most adverse stock condition" (June 9, 2000 letter from William Stelle, Jr., Regional Administrator, NMFS to Jim Lone, Chair, PFMC). These Council, SSC, STT, IMST, OCN Work Group, and NMFS concerns have provided the focus for our initial discussions and analyses.

METHODS

Based upon recommendations from the Council, SSC, STT and the IMST, the OCN work group identified a need to focus immediate attention on the following: 1) review the current status of OCN coho based upon current adult return and recruitment data; 2) define a new "Critical" parental spawner trigger point for OCN coho that is the minimum spawner density required to avoid the significantly increased risk of extinction associated with depensatory demographic effects; 3) identify a new "Extremely Low" marine survival category point that recognizes the very poor marine survival experienced by OCN coho in recent years; 4) construct an expanded version of the Plan Amendment 13 harvest management matrix that incorporates these two new trigger points; and 5) define the new parental spawner and marine survival trigger points based upon results of the habitat based production model.

Analysis of Current Status of OCN Coho

Re-calibrated fishery impacts, spawner abundance, and total pre-fishery population data for OCN coho were used to examine population trends. Trends in pre-fishery ocean population size were examined for the entire OCN aggregate. Trends in spawner abundance and recruitment were examined by sub-aggregate.

Population Production Models

A habitat based production model constructed by Nickelson and Lawson (1998) that incorporates environmental, demographic, and genetic stochasticity was used to examine changes in extinction rates with decreasing parental spawner abundance. This analytical approach takes advantage of an established and peer reviewed production model that was used during the risk assessment analysis for Plan Amendment 13 (ODFW and NMFS 1998). It also addresses the need identified by the SSC, STT, and IMST for an explicit link between management trigger points and a biologically based population production model for OCN coho. Hereafter, this analytical tool will be referred to as the Nickelson and Lawson Model.

A simpler deterministic version of the Nickelson and Lawson Model was used to assess population responses to parental spawner and marine survival trigger points. This deterministic model was also used to establish exploitation rates that would not hinder recovery of OCN coho under varying conditions of marine survival and parental spawner abundance. The model employed the density dependent freshwater survival equation from Nickelson and Lawson (1998) to predict changes in population abundance in the best habitat that might occur at different combinations of spawner abundance and harvest impact. The equation is as follows:

$$S_{t+3} = S_t Efm(1-h) \qquad [1]$$

where:
S = the OCN coho spawning population,
t = the year,
E = 1,250 eggs per spawner, assuming an average fecundity of 2,500 eggs per female and a 1:1 sex ratio,
f = a density dependent freshwater survival function 0.338(0.079 $P^{-0.669}$) where P is the percent of full seeding of the best habitat,
m = marine survival rate for wild fish in a given category, and
h = harvest impact.

Equation [1] was used to determine the spawner escapement that would result from a specific harvest impact. It was also used to estimate the range of spawner populations anticipated to occur in each cell of the matrix. By rearranging Equation [1], the harvest impact that would result in a predetermined spawner escapement was determined:

$$h = 1 - \left[S_{t+3} / S_t Efm \right]. \qquad [2]$$

With the exception of the case of estimating the upper range of expected spawner population, the value of m used in all calculations was the minimum observed survival rate for a given marine survival category (except for an outlier in the medium category that was excluded from the analysis because it resulted from an El Nino event). Use of the minimum observed survival rate resulted in the development of allowable harvest impacts based on conservative estimates of population productivity.

Analysis of Parental Spawner Categories

"Critical" Category

When a stock is at low abundance a primary management objective is to avoid reducing spawner escapements to a level that increases the risk of extinction. Identifying this point is a difficult task due, in part, to our lack of information about the behavior of populations at low abundance. Genetic analyses conclude that several hundred active spawners are needed in a population for preserving genetic diversity (Lynch 1990, Waples 1990). Ecological studies suggest that one or two hundred spawners per mile are needed for a fully functioning ecosystem (Bilby et. al. 1998), and that lower spawner densities lead to smaller juvenile salmon with potentially lower survival rates (Cederholm, et al. 2000). In addition to genetic and ecological effects there is thought to be decreased reproductive success at low population sizes due to random effects. This phenomenon is termed "depensation." McElhaney, et al. (2000) provide a more thorough discussion of risks to salmon populations at low abundances.

The technique we used to identify risk of extinction as a function of population size focused on the depensatory influence of random events on spawning success at low densities. These effects include skewed sex ratios, asynchronous escapement timing, redd scouring, and other factors that can prevent spawners from finding mates, or from reproducing successfully if they do mate. Our analysis used the Nickelson and Lawson Model.

In this analysis we ran the model starting from actual 1994 population sizes. We simulated four broods with 10% marine survival to fill each basin with fish, then simulated 16 generations with 1% marine survival to observe population decline including a large number of extinction events. Fishery exploitation rates of 0.00 and 0.08 were modeled. All coastal basins were modeled, and 1,000 iterations of the model were run for each level of fishing impacts.

To assess risk of extinction as a function of population size, we first converted spawner abundance to fish per mile (fpm) by dividing total spawners by the number of miles in each basin. We then looked at the population density in each of the first twelve low-survival generations and looked ahead four generations for extinction events. For this analysis extinction was defined as <0.05 fish per mile. Starting populations were sorted into bins of 0.1-1, 1.1-2, ... 9.1-10, 10.1-20, and >20 fpm, with a probability of extinction tabulated for each bin.

"Very Low", "Low", "Medium", and "High" Parental Spawner Categories

The Habitat Based Production Model suggests that productivity of the population at spawner densities above the critically low level are much more sensitive to variations in marine survival than to spawner abundance. Consequently, for parental spawner density levels above the critically low level we have opted to retain the categories in the existing matrix. Typically, so long as spawner abundance is out of the critically low category it is not the most significant determinant of recovery but is an important measure of recovery success. Spawner abundance categories in the current matrix for other than critically low spawner densities are adequate for rapid recovery of the population when marine survivals are at levels adequate for recruits per spawner of greater than one.

Analysis of Marine Survival Categories

The ratio of jacks per smolt at Columbia River and Oregon Coastal hatcheries has been retained as the best pre-season indicator of marine survivals for adult OCN returns expected in the current year. The fit of jacks per smolt on adults per smolt for each brood year of hatchery production from 1967 through 1996 is good (Figure 2).

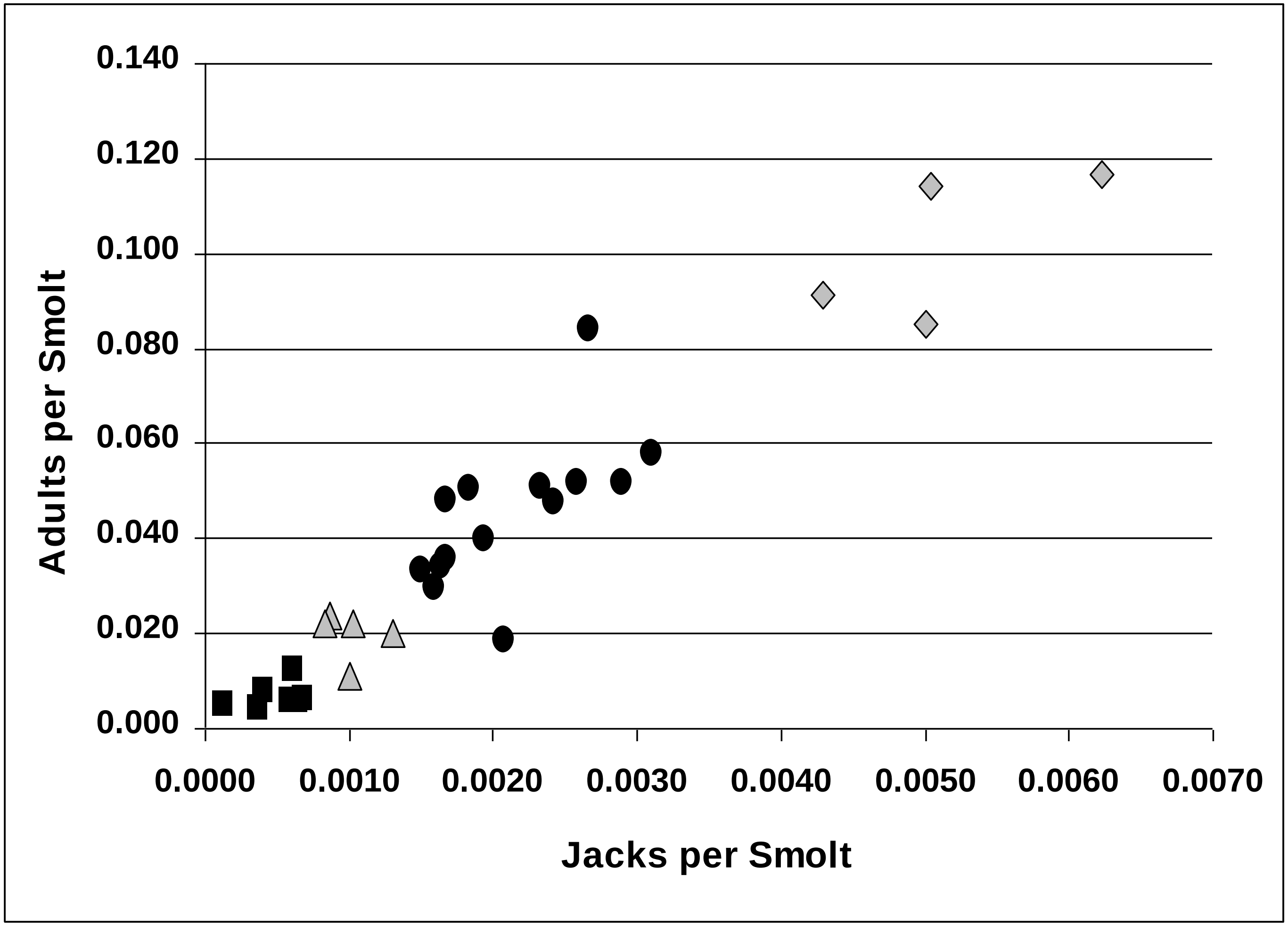

Figure 2. Relationship of jack:smolt versus adult:smolt ratios for OPI hatchery coho (the four different shaded symbols represent the four new marine survival categories in the revised harvest management matrix).

Groupings in these empirical data were useful for identifying preliminary boundaries of four marine survival categories. The Deterministic Model was subsequently used to define the population production potential for each of these categories. The categories are defined as follows:

"Extremely Low" -At the upper bound of this category marine survival would be expected to be at a level such that populations would fail to replace themselves even in the absence of harvest.

"Low" - Average marine survival in this category should result in populations at 50-100% of full seeding in the absence of harvest, depending upon beginning population size.

"Medium" - When marine survivals are in this category the population, on average, experiences recruitment >1.5 across the entire spectrum of parental spawner abundance. By this definition the "Medium" category would functionally encompass all marine survivals greater than those observed in the "Low" category. However, groupings of the empirical data in the relationship between jacks per smolt and adults per smolt (Fig. 1) clearly point to a fourth category of higher marine survival and were useful for identifying an upper boundary for the "Medium" category.

"High" - This category remained the same as originally designed in Amendment 13. Empirical data in the relationship between jacks per smolt and adults per smolt (Fig. 1) were useful for identifying a group of marine survival values in the upper end of the range that correspond to this category.

RESULTS

Current Status of OCN Populations and Progress Towards Rebuilding

Ocean coho populations began to decline in the mid-1970's (Figure 3). Although Council action has resulted in major reductions in fisheries related impacts on these populations in the last decade the decline has continued. Based upon criteria in the current harvest management matrix of Plan Amendment 13, one or more of OCN coho stock components (sub-aggregates) have been in the "Low" parental spawner category every year in the last decade (Table 2, Figure 4). Except for 1999, all those same years also had at least one sub-aggregate in the <19% of full seeding category and at least one major basin with spawner abundance less than 10% of full seeding. Moreover, an average of more than 20% of all major basins had escapements less than 10% of full seeding, 40% were at less than 38% of Level 1 (19% of full seeding), and two thirds were below Level 1 (50% of full seeding)(Figure 5). Most recently, more than 40% of all major basins in 1997 and 1998 had spawner densities at critical levels of less than 10% of full seeding. In those

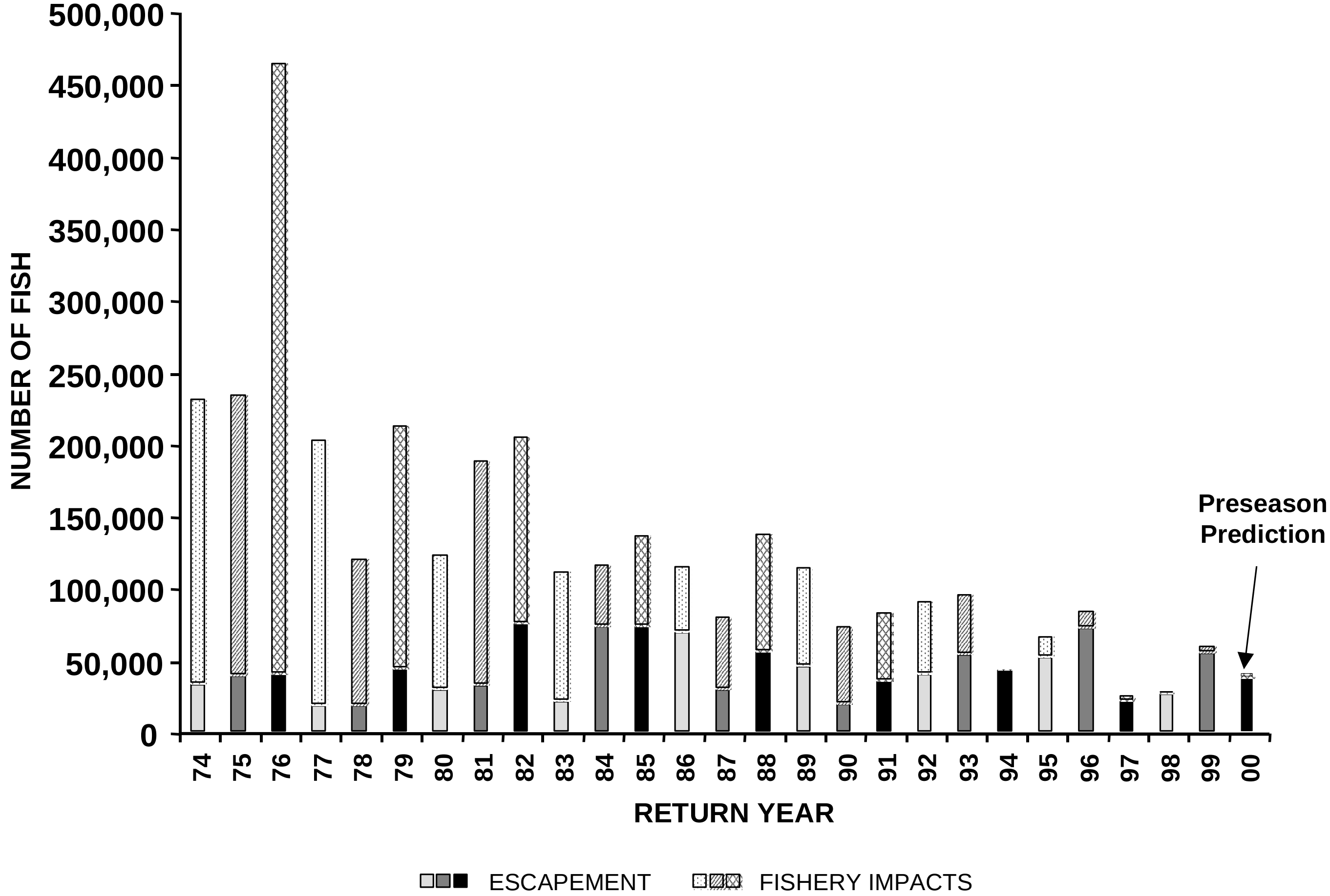

Figure 3. Total annual pre-fishery ocean population size of adult OCN coho. The population for each return year is shown as stacked bars with hatched portions depicting fishery-related impacts and solid portions depicting spawning escapement. The cohorts originating from the 1971, 72, and 73 brood cycles are depicted by light gray, gray, and black, respectively.

Basin	Full Seeding	Annual SRS Spawning Escapement Estimate in Numbers of Fish and as Precent of Full Seeding																			
		1990		1991		1992		1993		1994		1995		1996		1997		1998		1999	
		No.	%	No.	%	No.	% Full Seeding	No.	% Full Seeding	No.	% Full Seeding	No.	% Full Seeding	No.	% Full Seeding	No.	% Full Seeding	No.	% Full Seeding	No.	% Full Seeding
Nehalem	17,500	1,552	8.9%	3,975	22.7%	1,268	7.2%	2,265	12.9%	2,007	11.5%	1,463	8.4%	1,057	6.0%	1,173	6.7%	1,190	6.8%	3,410	19.5%
Tillamook	2,000	265	13.3%	3,000	150.0%	261	13.1%	860	43.0%	652	32.6%	289	14.5%	661	33.1%	388	19.4%	271	13.6%	2,119	106.0%
Nestucca	1,800	189	10.5%	728	40.4%	684	38.0%	401	22.3%	313	17.4%	1,811	100.6%	519	28.8%	271	15.1%	169	9.4%	2,117	117.6%
Direct Ocean Tribs	400	191	47.8%	1,579	394.8%	209	52.3%	983	245.8%	485	121.3%	319	79.8%	1,043	260.8%	314	78.5%	946	236.5%	698	174.5%
Northern	21,700	2,197	10.1%	9,282	42.8%	2,422	11.2%	4,509	20.8%	3,457	15.9%	3,882	17.9%	3,280	15.1%	2,146	9.9%	2,576	11.9%	8,344	38.5%
Siletz	4,300	441	10.3%	984	22.9%	2,447	56.9%	400	9.3%	1,200	27.9%	607	14.1%	763	17.7%	336	7.8%	394	9.2%	1,203	28.0%
Yaquina	7,100	381	5.4%	380	5.4%	633	8.9%	549	7.7%	2,448	34.5%	5,668	79.8%	5,127	72.2%	384	5.4%	365	5.1%	2,248	31.7%
Alsea	15,100	1,189	7.9%	1,561	10.3%	7,029	46.5%	1,071	7.1%	1,279	8.5%	681	4.5%	1,637	10.8%	680	4.5%	213	1.4%	1,923	12.7%
Siuslaw	22,800	2,685	11.8%	3,740	16.4%	3,440	15.1%	4,428	19.4%	3,205	14.1%	6,089	26.7%	7,625	33.4%	668	2.9%	1,089	4.8%	2,617	11.5%
Direct Ocean Tribs	5,700	895	15.7%	67	1.2%	1,821	31.9%	1,331	23.4%	1,743	30.6%	573	10.1%	2,975	52.2%	774	13.6%	1,222	21.4%	3,379	59.3%
North -Central	55,000	5,591	10.2%	6,732	12.2%	15,370	27.9%	7,779	14.1%	9,875	18.0%	13,618	24.8%	18,127	33.0%	2,842	5.2%	3,283	6.0%	11,370	20.7%
Umpqua	29,400	3,737	12.7%	3,600	12.2%	2,152	7.3%	9,311	31.7%	1,185	4.0%	11,349	38.6%	9,749	33.2%	2,233	7.6%	8,426	28.7%	6,471	22.0%
Coos	7,200	2,273	31.6%	3,813	53.0%	16,545	229.8%	15,284	212.3%	14,685	204.0%	10,351	143.8%	12,128	168.4%	1,127	15.7%	3,167	44.0%	4,676	64.9%
Coquille	5,400	2,712	50.2%	5,651	104.6%	2,115	39.2%	7,384	136.7%	5,035	93.2%	2,116	39.2%	16,169	299.4%	5,720	105.9%	2,466	45.7%	3,044	56.4%
Coastal Lakes	8,000	4,393	54.9%	7,251	90.6%	1,986	24.8%	10,145	126.8%	5,841	73.0%	11,216	140.2%	13,493	168.7%	8,603	107.5%	11,107	138.8%	19,499	243.7%
South Central	50,000	13,115	26.2%	20,315	40.6%	22,798	45.6%	42,124	84.2%	26,746	53.5%	35,032	70.1%	51,539	103.1%	17,683	35.4%	25,166	50.3%	33,690	67.4%
Rogue	5,400	2,796	51.8%	765	14.2%	1,935	35.8%	174	3.2%	5,303	98.2%	4,221	78.2%	5,386	99.7%	8,300	153.7%	3,300	61.1%	2,000	37.0%
Southern	5,400	2,796	51.8%	765	14.2%	1,935	35.8%	174	3.2%	5,303	98.2%	4,221	78.2%	5,386	99.7%	8,300	153.7%	3,300	61.1%	2,000	37.0%
Total	132,100	23,699	17.9%	37,094	28.1%	42,525	32.2%	54,586	41.3%	45,381	34.4%	56,753	43.0%	78,332	59.3%	30,971	23.4%	34,325	26.0%	55,404	41.9%

Table 2. Estimated number of OCN coho required to fully seed optimum spawning habitat in stock sub-aggregates and their constituent major basins. The annual SRS estimates of OCN coho spawning escapement in each of those basins expressed as numbers of spawners and as a percent of full seeding. Shaded cells in the sub-aggregate subtotals indicate instances when spawner abundance is in the "Critical" (< 4 fish per mile) status. Shaded totals indicate that the status of the aggregate as a whole would be "Critical" under proposed new criteria.

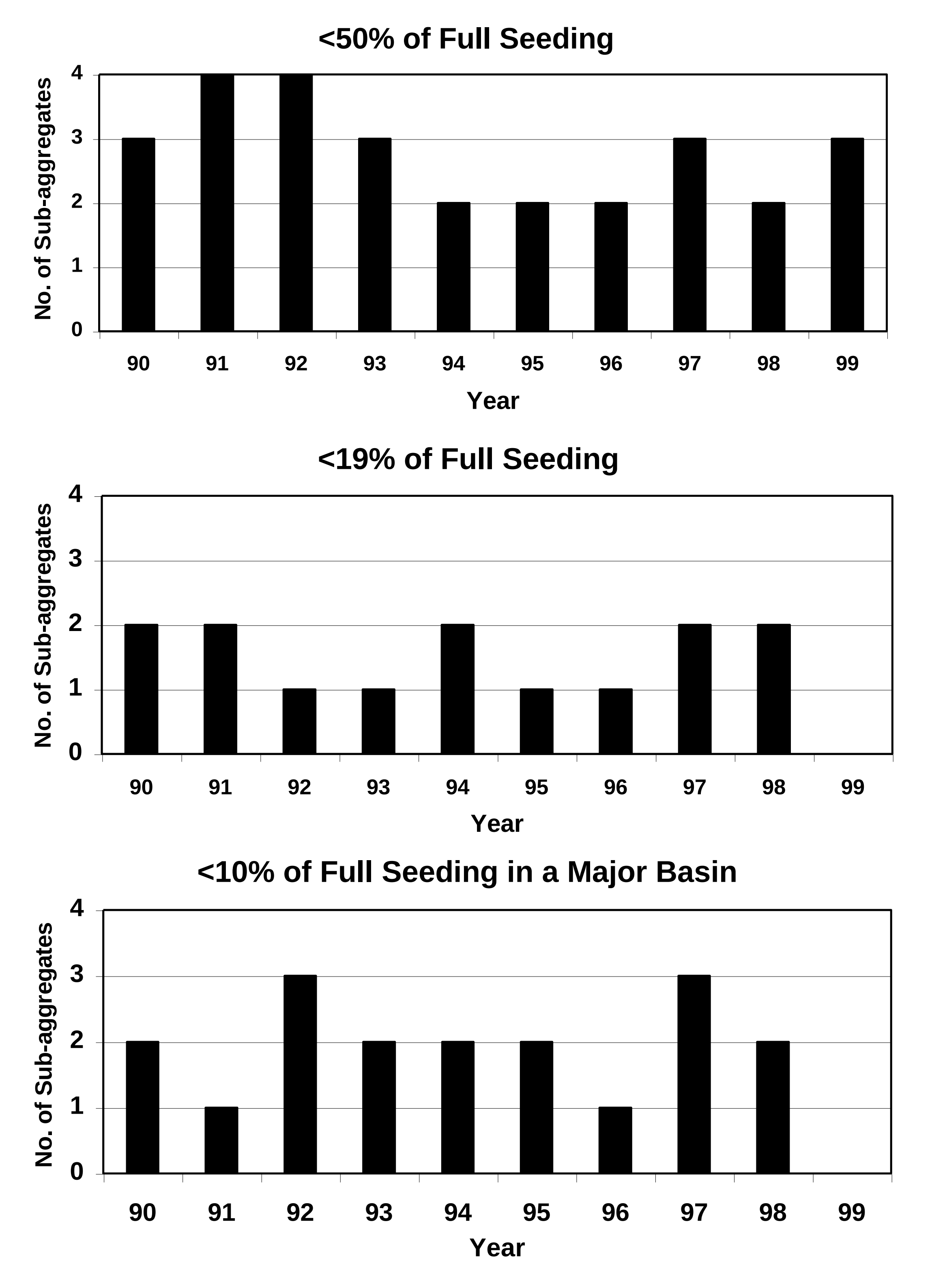

Figure 4. Annual number of sub-aggregates with spawner abundance <50% of full seeding, < 19% of full seeding, or with at least on major basin with <10% of full seeding, 1990-1999.

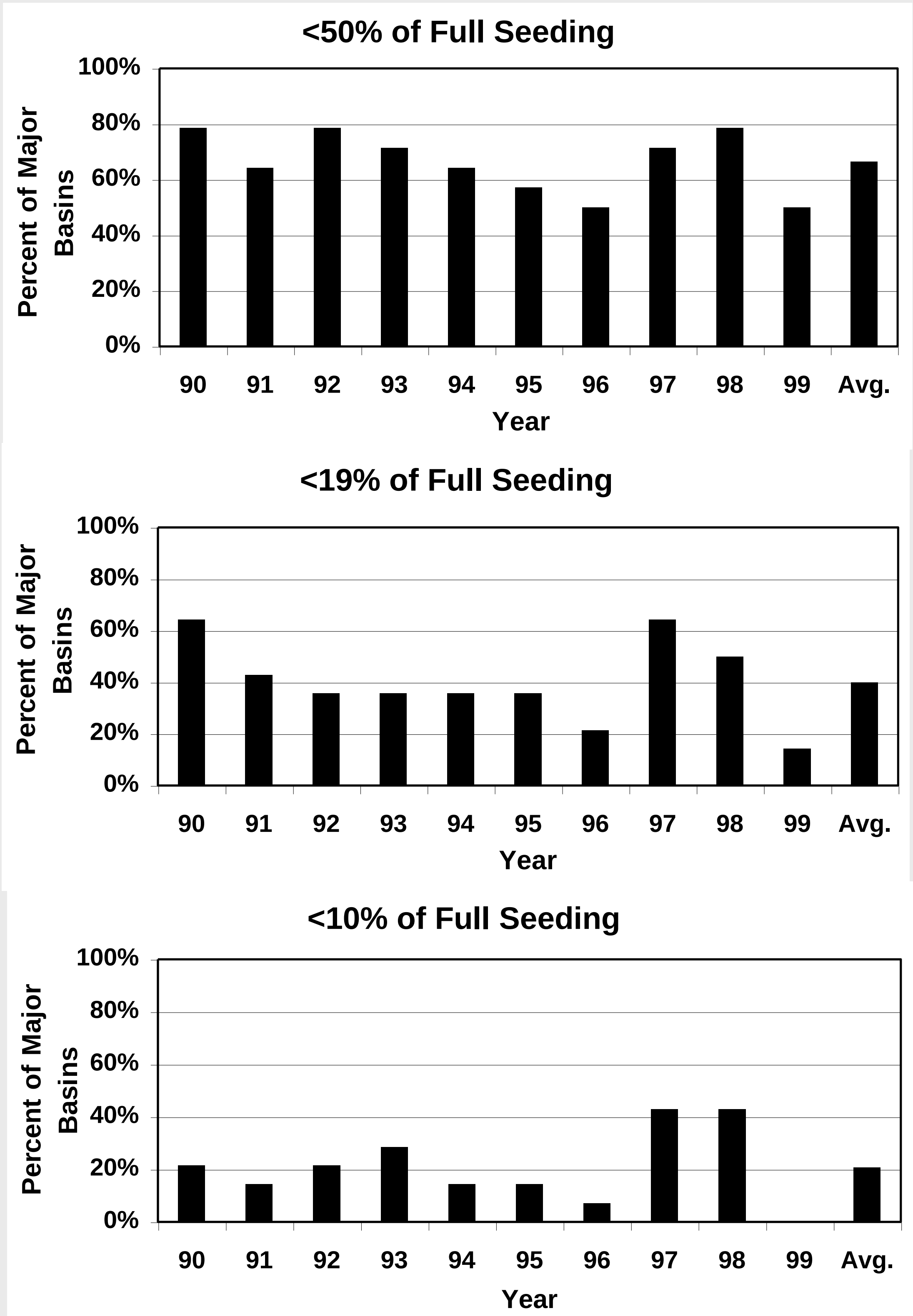

Figure 5. Annual and average percentage of major coastal basins with spawner abundance <50%, 19%, and 10% of full seeding in the last decade (1990-1999).

years spawner abundance in more than half the basins were in the "Extremely Low" (38% of Level 1) category. The situation was more hopeful in 1999 when no major basin had less than 10% of full seeding and only 14% were less than 38% of Level 1. However, in 1999 more than half of all basins had seeding levels at less than Level 1.

Marine survivals as represented by jacks:smolts ratios for OPI hatchery stocks declined from "High" levels in the early 1970's to "Medium" and "Low" levels by the early 1980's (Figure 6). Survivals remained fairly constant thereafter for the next decade. However, by the early 1990's, they began to decline again and survivals experienced by the 1991-93 brood cycles (1994-96 adult returns) were "Extremely Low". Marine survival remained "Extremely Low" for fish produced from the 1994 and 1995 brood cycles but improved to the lower end of the Amendment 13 "Medium" category for the 1996 and 1997 brood cycles. As might be expected, recruitment in the face of such low marine survival has been very poor and the 1994-96 broods failed to replace themselves (Figure 7). Poor spawner to recruitment ratios are evident among all sub-aggregates (Figure 8). Modest improvements in marine survival and OCN productivity have occurred in the last two years but evidence for a long term increasing trend is lacking.

Definitions of Marine Survival Categories

Given the proposed breakdown of marine survival categories the jacks:smolts ratio has predicted the category accurately in 27 out of 30 years. Twice, survival was under-predicted (1986 and1992 adult returns) and only once survival was over predicted. This latter case was the 1983 El Niño year during which, as predicted by some, additional adult mortality occurred after the jacks returned. This phenomenon is now widely recognized and should be anticipated in the future. The mean values of all four survival categories are highly significantly different from each other ($p < 0.01$).

"Extremely Low" Marine Survival

This category corresponds to the very poor survival experienced by adults returning in 1992-98 and is predicted by jacks:smolts ratios of <0.0008 (Table 3). Under the criteria of this category, it is expected that marine survival of hatchery fish will be less than 1%, as has been the case for six of the seven years in the empirical data. Adult marine survival observed in the "Extremely Low" category ranges from 0.5% to 1.3% and averages 0.7%. For modeling purposes, it was assumed that marine survival of wild fish in this category would be twice that of hatchery fish (Nickelson 1986, Seiler 1989).

"Low" Marine Survival

The new "Low" marine survival category encompasses values from the low end of the original "Medium" category, which was extremely wide, ranging from less than 2% marine survival to over 8%. The new "Low" adult marine survival category is predicted

17

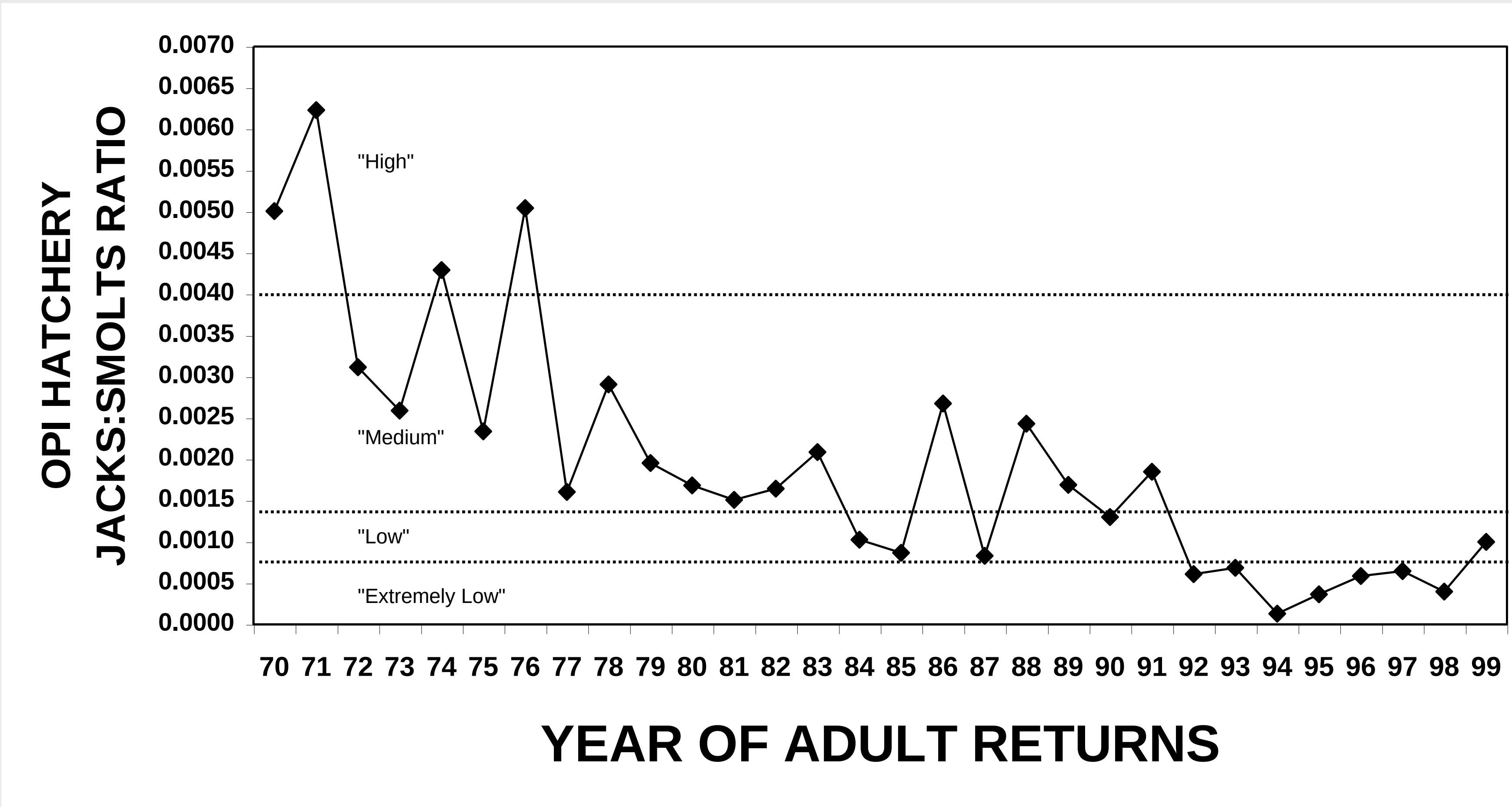

Figure 6. Ratios of jacks to smolts for OPI hatchery coho for adult return years 1970-1999. The ratios are used in the Amendment 13 matrix as a surrogate for adult marine survivals experienced by OCN coho. The proposed new "Extremely Low", "Low", "Medium", and "High" categories are labeled and delineated by dotted lines across the chart.

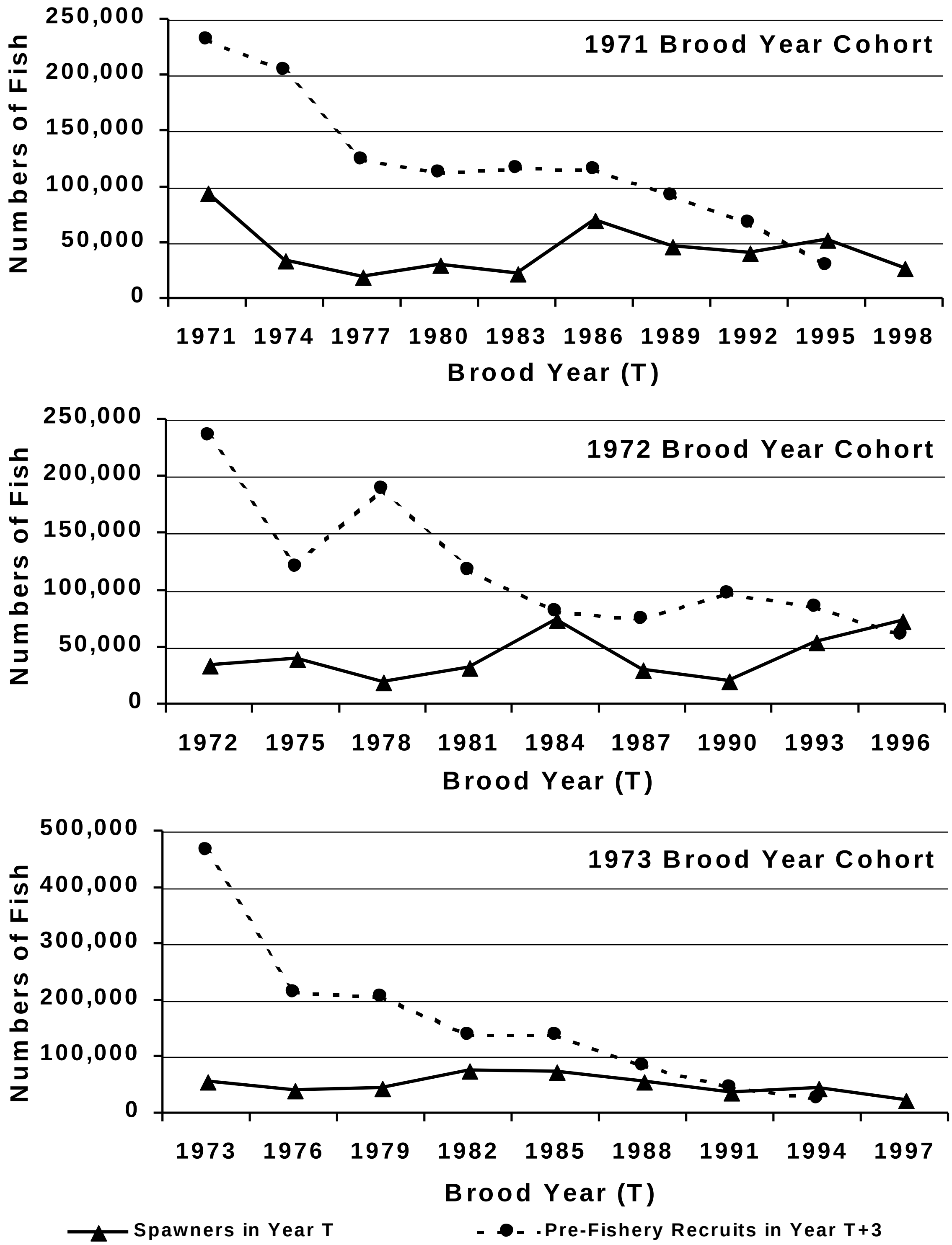

Figure 7. Annual parental spawners and resulting pre-fishery recruits for the cohorts originating from the 1971, 72, and 73 brood cycles.

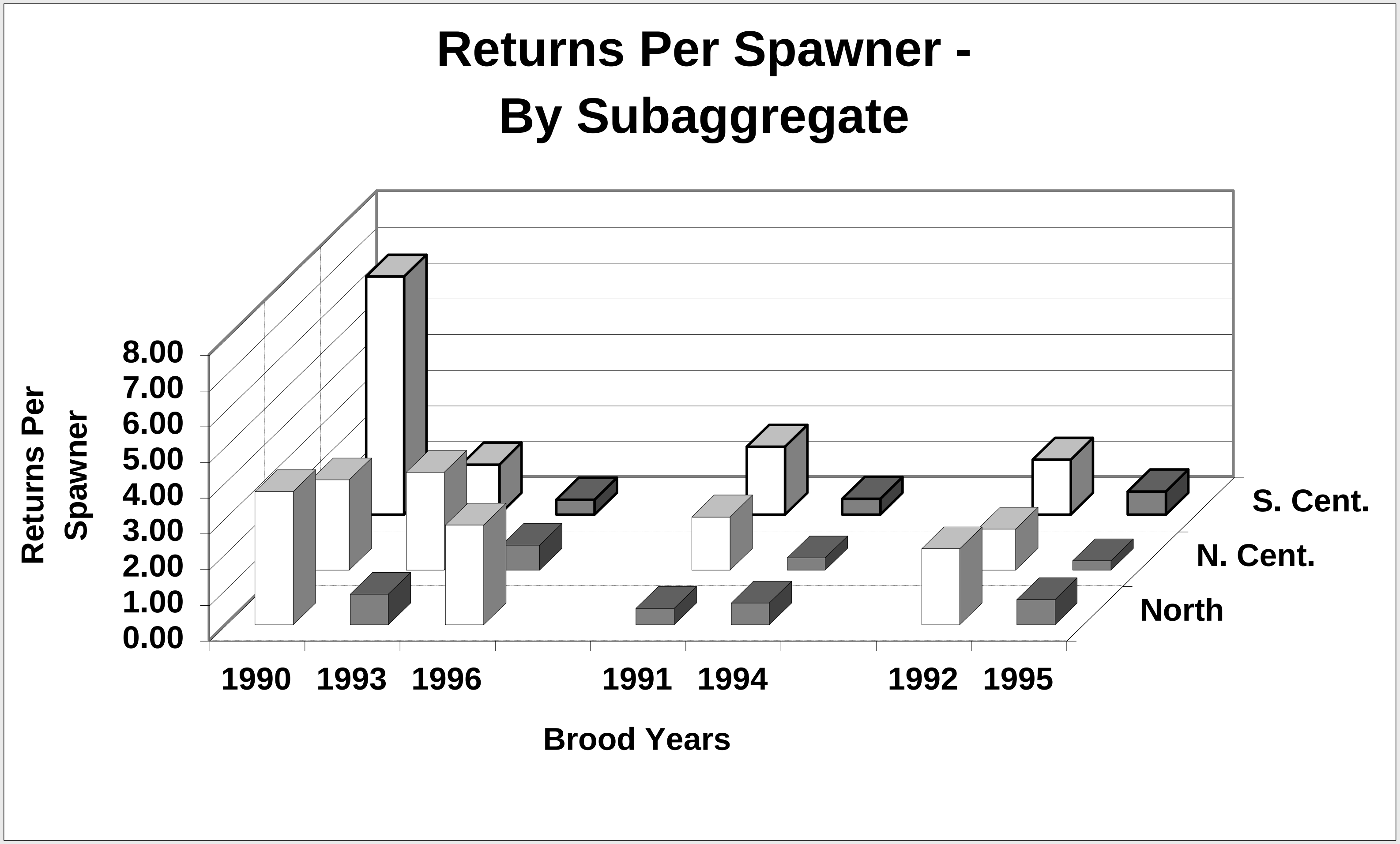

Figure 8. Returns per spawner for OCN coho sub-aggregates for the 1990, 91, and 92 brood cycles. Darkly shaded bars indicate returns per spawner of less than one (failure to replace).

Table 3. Prediction of marine survival categories from OPI hatchery smolt-to-jack survival rates(1970-1999). Adult numbers have been updated using re-scaled SRS-based estimates. Numbers for smolts are in millions, jacks and adults in thousands. The former "Medium" category encompassed the "Medium" category shown in this table plus the shaded rows in "Low" category. The former "Low" category included the unshaded "Low" year in this table plus all years in the new "Extremely Low" category.

Year (t)	Smolts (t-1)	Jacks (t-1)	Jacks/Smolt	Adults (t)	Adults/Smolt		Adults/Smolt
		HIGH ADULT MARINE SURVIVAL					
		(Predicted by Jacks:Smolts Ratios ≥0.0040)					
1971	28.8	179.4	0.0062	3365.0	11.7%		
1976	34.0	171.5	0.0050	3885.3	11.4%	Average	10.2%
1970	32.4	162.2	0.0050	2765.1	8.5%	Maximum	11.7%
1974	33.6	144.2	0.0043	3071.1	9.1%	Minimum	8.5%
		MEDIUM ADULT MARINE SURVIVAL					
		(Predicted by Jacks:Smolts Ratios of >0.0014 - 0.0040)					
1972	33.3	103.7	0.0031	1924.8	5.8%		
1978	35.5	103.2	0.0029	1824.1	5.1%		
1986	29.0	77.6	0.0027	2435.8	8.4%		
1973	35.3	91.4	0.0026	1817.0	5.1%		
1988	35.0	85.1	0.0024	1666.1	4.8%		
1975	32.6	76.2	0.0023	1652.8	5.1%		
1983	32.7	68.2	0.0021	595.7	1.8%	El Nino	
1979	37.1	72.5	0.0020	1476.7	4.0%		
1991	37.2	68.7	0.0018	1874.8	5.0%		
1989	36.0	60.8	0.0017	1721.4	4.8%		
1980	34.2	57.6	0.0017	1224.0	3.6%		
1982	37.3	61.3	0.0016	1266.8	3.4%	Average	4.5%
1977	33.5	53.7	0.0016	987.5	2.9%	Maximum	8.4%
1981	32.3	48.7	0.0015	1064.5	3.3%	Minimum	2.9%
		LOW ADULT MARINE SURVIVAL					
		(Predicted by Jack:Smolts Ratios of 0.0008 - 0.0014)					
1990	35.9	46.7	0.0013	718.4	2.0%		
1984	30.9	31.7	0.0010	689.4	2.2%		
1999	29.1	29.1	0.0010	322.4	1.1%	Average	2.0%
1985	30.0	26.0	0.0009	717.5	2.4%	Maximum	2.4%
1987	39.5	32.8	0.0008	880.1	2.2%	Minimum	1.1%
		EXTREMELY LOW ADULT MARINE SURVIVAL					
		(Predicted by Jacks:Smolts Ratios < 0.0008)					
1993	39.7	27.2	0.0007	261.7	0.7%		
1997	31.6	20.4	0.0006	197.2	0.6%		
1992	42.1	25.6	0.0006	540.8	1.3%		
1996	29.5	17.3	0.0006	184.9	0.6%		
1998	24.6	9.8	0.0004	202.6	0.8%	Average	0.7%
1995	32.3	11.8	0.0004	147.1	0.5%	Maximum	1.3%
1994	39.5	5.1	0.0001	202.4	0.5%	Minimum	0.5%

by jacks:smolts ratios of 0.0008-0.0014. Under the conditions of this category, it is expected that marine survival of hatchery fish will range from 1% to possibly 3%. Marine survival observed in the Low category ranges from 1.1% to 2.4% and averages 2.0%. The 1987 data point is also in this category. It was originally grouped with what is now the Extremely Low group, but was almost double any other adult survival value in the group.

For modeling purposes, it was assumed that marine survival of wild fish in this category would be 1.5 times that of hatchery fish.

"Medium" Marine Survival

Marine survival observed in the new "Medium" survival category ranges from 2.9% to 8.4%, except in an El Niño year (1983), and averages 4.5%. Under the conditions of this category, it is expected that marine survival of hatchery fish will range from slightly less than 3% to a high of 6-8%. This category is predicted by jack:smolt ratios of >0.0014-0.0040. For modeling purposes, it was assumed that marine survival of wild fish would be 1.5 times that of hatchery fish at the low end of this category and equal to that of hatchery fish at the high end of this category.

"High" Marine Survival

The difference between High and Medium survival is by far the most obvious and discernable. The cluster of empirical data points in this category is easily recognized in the plotted relationship between jacks per smolt and adults per smolt (Figure 2). Adult marine survival observed in the High category ranges from 8.6% to 11.7% and averages 10.2%. Under the conditions of this category, it is expected that marine survival of hatchery fish will be greater than 8%. This category is predicted by jack:smolt ratios >0.0040. For modeling purposes, it was assumed that marine survival of wild fish in this category would be the same as that of hatchery fish (Nickelson 1986).

Definitions of Parental Spawner Categories

"Critical" Parental Spawner Density

The pattern in probability of extinction in four generations as a function of parental spawner densities was consistent across basins. Larger basins, and basins with higher quality habitat, showed overall lower extinction probabilities, as expected. But all basins showed an increase in extinction probability with declining spawner densities. The probabilities in all but the Rogue River trended higher below densities of 3 to 5 fpm. Because the response of most basins was so similar, we combined the results across all basins to arrive at a single curve for each fishery exploitation rate. Each expresses the probability of extinction in four generations as a function of spawner density (Figure 9). The Rogue River is one notable exception to the general trend for the

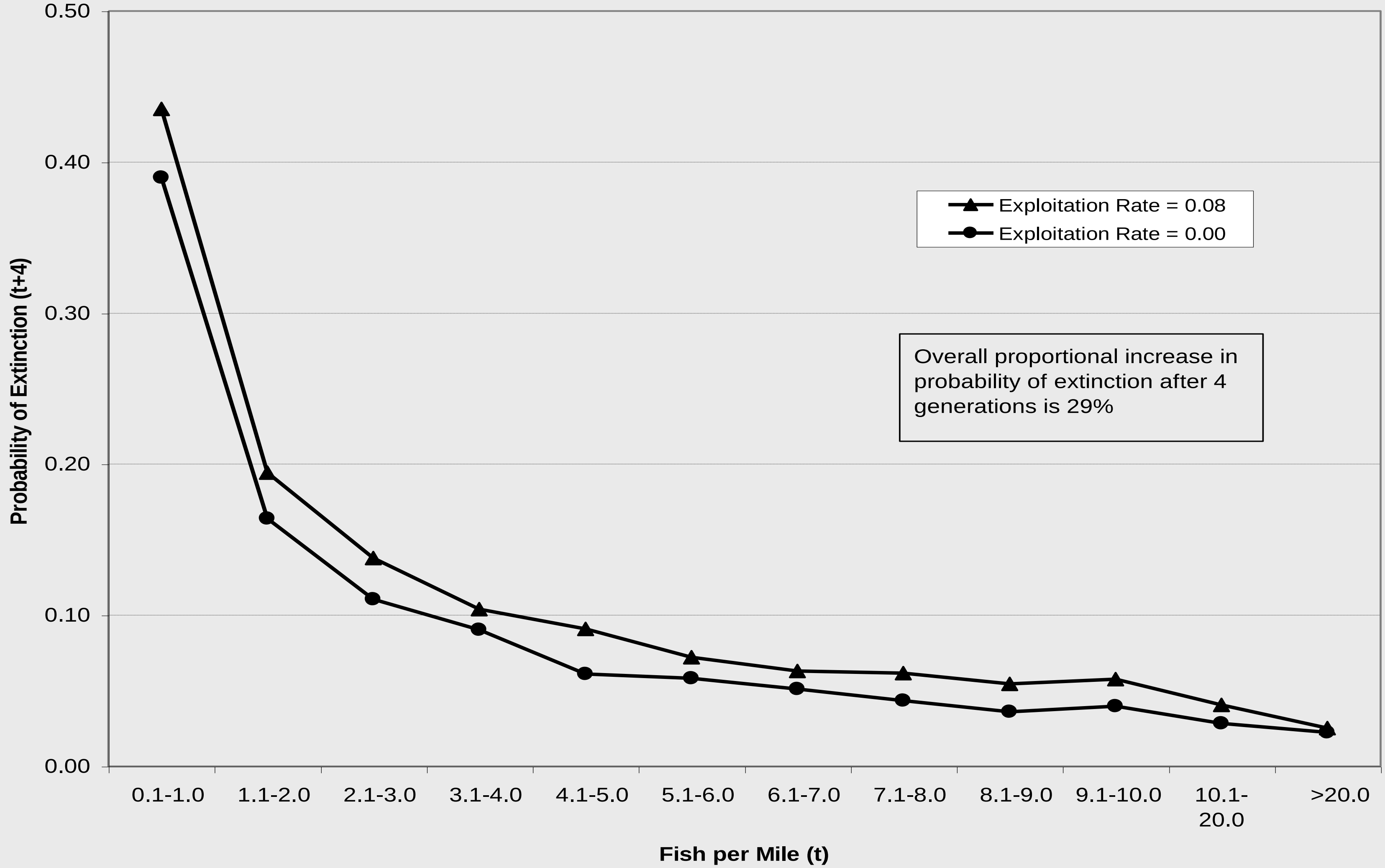

Figure 9. Probability of basin-level extinction in 4 generations as a function of spawner density for exploitation rates of 0.00 and 0.08. All Oregon coastal basins are combined.

large major coastal basins to resemble the OCN stocks in aggregate with respect to extinction probability versus spawner density. The ratio of high quality habitat to total habitat in the Rogue Basin is lower than in other coastal basins. Spawner densities in the Rogue must be well below the four fish per mile level before extinction probabilities increase significantly. For this reason, we have opted to treat the Rogue Basin (hence the Southern Sub-aggregate) differently than all others and express "Critical" spawner status as 12% of full seeding rather than in density of spawners. The value of 12% is consistent with the average percent of full seeding in other basins when four fish per mile is achieved.

As with all model results, these curves must be interpreted carefully. The absolute extinction probabilities are not very meaningful, as they are sensitive to the marine survival rate chosen and many of the modeling parameters. What is informative and important is the shape of the curve: as populations drop below about five fish per mile the risk of extinction starts to rise rapidly. A fishery exploitation rate of 0.08 increased the probabilities by only a few percentage points. However, the absolute extinction probabilities are less meaningful than the difference between the two runs. Overall extinction probabilities of basins in four generations were 0.13 without fishery impacts and 0.17 with an exploitation rate of 0.08, an increase of 29%.

"Very Low", "Low", "Medium", and "High" Parental Spawner Categories

The "Very Low" Parental Spawner category in the new matrix ranges from 12% to 19% of full seeding which corresponds with the lowest parental spawner category in the existing matrix that is defined as < 19% of full seeding. The "Low", "Medium", and "High" Parental Spawner Categories are identical to those in the existing matrix and are as follows: 19%-50% of full seeding; 50%-75% of full seeding; and 75% - 100% of full seeding for parental spawners and 50%-75% of full seeding for grandparental spawners.

Fishery Impact Rates

The evolution of the newly proposed harvest management matrix from the matrix that is currently in Amendment 13 is shown in Table 4. Table 5 is the final version of the proposed new matrix showing new spawner abundance and marine survival criteria and new impact rates. Appendix 3 shows the same matrix with ranges of spawner escapement projections for each cell. Fishery impact rates appropriate for observed conditions of marine survival and parental spawner abundance appear in cells of the matrix that are delineated by the intersections of vertical boundary lines for marine survival categories and horizontal boundary lines for parental spawner categories. With respect to parental spawner categories, decisions within the matrix are dictated by the performance of the weakest sub-aggregate. Hence, if the weakest sub-aggregate is categorized as "Critical" with respect to parental spawner abundance, managers will be confined to the "Critical" row of the matrix.

Table 4. Evolution of revisions to the Plan Amendment 13 harvest management matrix shown in increments from the existing matrix (A) to the final proposed matrix (D). The creation of the new "Very Low" spawner abundance category from criteria used to define the <10-13% impact rate cell in the existing matrix is shown in B. The inclusion of the new "Critical" parental spawner and "Extremely Low" marine survival categories are shown in C. Unshaded cells correspond to cells in the existing matrix, the lightly shaded cells correspond to cells in the existing matrix that have been extended, darkly shaded cells represent the new cells, and stippling indicates harvest rates that have been changed.

A. Existing Plan Amendment 13 harvest management matrix.

	SMOLT TO ADULT MARINE SURVIVAL		
	Low	**Medium**	**High**
PARENT SPAWNER STATUS [b/]	ALLOWABLE TOTAL FISHERY IMPACT		
High Parent Spawners ≥75 % of full seeding *and* grandparent spawners ≥50% of full seeding	**≤15%**	**≤30%**	**≤35%**
Medium Parent spawners ≥50% of full seeding	**≤15%**	**≤20%**	**≤25%**
Low Parent spawners <50% of full seeding	**≤15%**	**≤15%**	**≤15%**
Parental Spawners <19% of full seeding	**≤10-13%**		

B. Extension of very low parental spawner status (10-13% impact rate cell) across matrix.

	SMOLT TO ADULT MARINE SURVIVAL		
	Low	**Medium**	**High**
PARENT SPAWNER STATUS [b/]	ALLOWABLE TOTAL FISHERY IMPACT		
High Parent Spawners ≥75 % of full seeding *and* grandparent spawners ≥50% of full seeding	**≤15%**	**≤30%**	**≤35%**
Medium Parent spawners ≥50% of full seeding	**≤15%**	**≤20%**	**≤25%**
Low Parent spawners <50% of full seeding	**≤15%**	**≤15%**	**≤15%**
Very Low Parental Spawners <19% of full seeding	**≤10-13%**	**≤10-13%**	**≤10-13%**

C. Addition of new "Critical" parental spawner and "Extremely Low" marine survival categories.

	SMOLT TO ADULT MARINE SURVIVAL			
	Extremely Low	**Low**	**Medium**	**High**
PARENT SPAWNER STATUS [b/]	ALLOWABLE TOTAL FISHERY IMPACT			
High Parent Spawners ≥75 % of full seeding	**≤8%**	**≤15%**	**≤30%**	**≤35%**
Medium Parent spawners ≥50% and <75% of full seeding	**≤8%**	**≤15%**	**≤20%**	**≤25%**
Low Parent spawners ≥19% and <50% of full seeding	**≤8%**	**≤15%**	**≤15%**	**≤15%**
Very Low Parent spawners > 4 fish per mile and < 19% of full seeding	**≤8%**	**≤10-13%**	**≤10-13%**	**≤10-13%**
Critical Parental Spawners ≤ 4 fish per mile	**0-8%**	**0-8%**	**0-8%**	**0-8%**

D. Final revised matrix

	SMOLT TO ADULT MARINE SURVIVAL			
	Extremely Low	**Low**	**Medium**	**High**
PARENT SPAWNER STATUS [b/]	ALLOWABLE TOTAL FISHERY IMPACT			
High Parent Spawners ≥75 % of full seeding	**≤8%**	**≤15%**	**≤30%**	**≤45%**
Medium Parent spawners ≥50% and <75% of full seeding	**≤8%**	**≤15%**	**≤20%**	**≤38%**
Low Parent spawners ≥19% and <50% of full seeding	**≤8%**	**≤15%**	**≤15%**	**≤25%**
Very Low Parent spawners > 4 fish per mile and < 19% of full seeding	**≤8%**	**≤11%**	**≤11%**	**≤11%**
Critical Parent spawners ≤ 4 fish per mile	**0-8%**	**0-8%**	**0-8%**	**0-8%**

Table 5. Proposed revisions to the harvest management matrix in Plan Amendment 13 showing allowable fishery impacts and ranges of resulting recruitment for each combination of parental spawner abundance and marine survival.

	Marine Survival Index (based on return of jacks per hatchery smolt)			
Parent Spawner Status [1/]	**Extremely Low** (<0.0008)	**Low** (0.0008 to 0.0014)	**Medium** (>0.0014 to 0.0040)	**High** (>0.0040)
High Parent Spawners > 75% of full seeding	E ≤ 8%	J ≤ 15%	O ≤ 30%	J ≤ 45%
Medium Parent Spawners > 50% & ≤ 75% of full seeding	D ≤ 8%	I ≤ 15%	N ≤ 20%	I ≤ 38%
Low Parent Spawners > 19% & ≤ 50% of full seeding	C ≤ 8%	H ≤ 15%	M ≤ 15%	H ≤ 25%
Very Low Parent Spawners > 4 fish per mile & ≤ 19% of full seeding	B ≤ 8%	G ≤ 11%	L ≤ 11%	Q ≤ 11%
Critical [2/] Parental Spawners ≤ 4 fish per mile	A 0 - 8%	F 0 - 8%	K 0 - 8%	P 0 - 8%

Sub-aggregate and Basin Specific Spawner Criteria Data

Sub-aggregate	Miles of Available Spawning Habitat	100% of Full Seeding	"Critical"		Very Low, Low, Medium & High		
			4 Fish per Mile	12% of Full Seeding	19% of Full Seeding	50% of Full Seeding	75% of full Seeding
Northern	899	21,700	3,596	NA	4,123	10,850	16,275
North - Central	1,163	55,000	4,652	NA	10,450	27,500	41,250
South - Central	1,685	50,000	6,740	NA	9,500	25,000	37,500
Southern	450	5,400	NA	648	1,026	2,700	4,050
Coastwide Total	4,197	132,100	15,636		25,099	66,050	99,075

1/ Parental spawner abundance status for the OCN aggergate assumes the status of the weakest sub-aggregate.

2/ "Critical" parental spawner status is defined as 4 fish per mile for the Northern, North-Central, and South-Central subaggergates. Because the ratio of high quality spawning habitat to total spawning habitat in the Rogue River Basin differs significantly from the rest of the basins on the coast, the spawner density of 4 fish per mile does not represent "Critical" status for that basin. Instead. "Critical" status for the Rogue Basin (Southern Sub-aggergate) is estimated as 12% of full seeding of high quality habitat.

"Critical" Parental Spawner Density Status (Cells A, F, K, and P)

The productivity of a population with parental spawner abundance in this category can be highly variable. Risk of extinction for a population in the "Critical" category increases rapidly as spawner densities decline because of demographic effects such as two spawners not being able to find each other. Under these conditions, any impacts other than natural mortality will increase the risk to long term viability of the population and should be avoided. Incidental fishery related impacts that occur when spawner abundance for the aggregate or any sub-aggregate falls within this category will increase the risk of extinction for the population and are not biologically justifiable. Hence, the range of suggested allowable harvest related impacts in management matrix cells in this category includes zero as an option.

"Extremely Low" Marine Survival (Cells B-E)

The population should not be expected to replace itself when in this survival category except when parent spawner status is "Very Low" or "Critical". In those latter circumstances, poor recruitment as a result of low spawner abundance may be offset by survival gains from compensatory effects associated with reduced juvenile densities in freshwater rearing areas. Therefore, since populations in this category cannot recover, even at optimal spawner densities, we should be in a conservation mode and attempt to minimize harvest impacts. The Council has previously recognized the need for conservation when these marine survival conditions existed in 1997 and 1998 and adopted pre-season impact rates below guidelines shown in the existing harvest management matrix.

When marine survivals persist in the "Extremely Low" category the population can sustain itself but only at levels that can dangerously approach the "Critical" level. Density dependent compensatory effects in the freshwater environment reduce the risk to the population from minor impacts other than natural mortality but caution is very important when populations are experiencing these conditions. The harvest impact of 8% for cells within this marine survival category is the lowest estimated OCN impact rate achieved to-date in coastwide salmon fisheries in the last decade. It is lower than the lowest <10-13% impact limit currently imposed by the matrix but is an attempt to reduce impacts from fisheries to the lowest level possible without precluding fisheries that have only incidental impacts on OCN coho. Model results verify that fishery impacts of 8% or less will likely not reduce the ability of the population to sustain at replacement levels or increase slightly as abundance approaches the "Critical" level.

Very Low Parent Spawner Status (Cells G, L, and Q)

The original impact rate of ≤10-13% has now been set at ≤11%. The 11% value is based on the average impact rate that has been achieved by the Council since the severely restrictive non-retention fisheries were implemented for coho in 1994. On average under conditions defined by these cells, parental spawners will not decline to the "Critical" level if harvest impacts are held to less than 11%. Originally, the reduced harvest impact of ≤10-13% was only required when parental spawner status is "Very Low" and marine survival status is "Low". The modification proposes to expand the application of "Very Low " parental spawner abundance across the higher marine survival categories as conservation and rebuilding measure.

Low Marine Survival (Cells H-J)

These cells were in the original matrix with the allowable harvest impact set at ≤15%. We do not propose any changes in these cells. When survival is at the low end of the "Low" marine survival category, the median population in the "Low" parent spawner status category should nearly replace itself at this harvest impact. Median spawner populations in the "Medium" and "High" categories should drop into the "Low" category at this harvest impact because these population levels are not able to replace themselves at the low-end marine survival.

Medium Marine Survival (Cells M-O*)*

We propose to leave the allowable harvest impact values of these cells the same as in the original matrix. The harvest impact of 15% in cell M should result in the median population in the "Low" parent spawner status category to increase to about the median population of the "High" category. The 20% and 30% harvest impacts of cells N and O, respectively should allow the median populations of these two parent spawner categories to increase to approximately full seeding of the best habitat.

High Marine Survival (Cells R-T)

We propose to increase the harvest impacts that are allowable when marine survival is in the high category. Marine survival in this range results in an extremely productive population. We propose maximum harvest impacts of 25%, 38%, and 45% when parent spawners are in the Low, Medium, High categories, respectively. These harvest impacts are based on the goal of achieving 150% of full seeding of the best habitat following harvest.

DISCUSSION

Parental spawner and marine survival data provide no evidence that recovery or rebuilding of OCN coho populations is imminent. The data strongly suggest that those populations may presently be particularly vulnerable to all fishing and non-fishing related impacts. In fact, under the new criteria described in this paper, OCN parental spawner status ranks as "Critical' in seven out of the last ten years (Figure 10). Near term Council management of ocean fisheries will likely continue to be constrained to areas of the management matrix defined by "Critical" or "Very Low" parental spawner abundance and "Low" marine survival. The SSC and the IMST have expressed

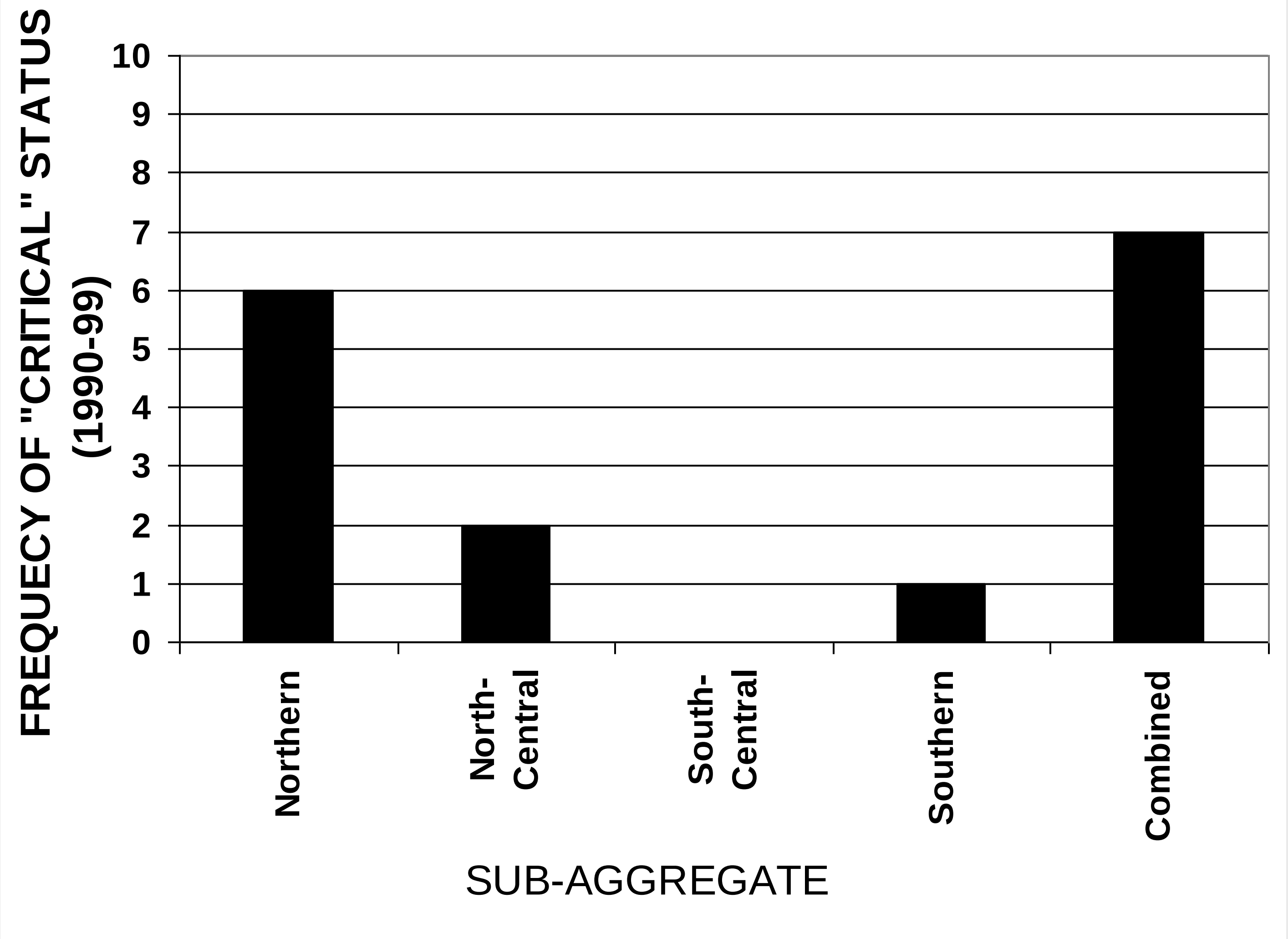

Figure 10. Frequency of occurrence of annual spawner abundance in the "Critical" category for individual OCN coho sub-aggregates and sub-aggregates combined in the last decade (1990-1999). "Critical" is defined as < four fish per mile for the Northern, North-Central, and South-Central sub-aggregates and <12% of full seeding for the Southern sub-aggregate. The OCN aggregate as a whole (Combined) assumes the status of the weakest sub-aggregate.

28

particularly strong concerns about the scientific justification for decision criteria and allowable impact rates when parental spawner abundance and marine survival are low. Under those conditions measurement imprecision for modeling parameters exacerbates uncertainties about predicted population responses.

Plan Amendment 13 represents a very conservative and precautionary approach to managing OCN coho that differs significantly from management under previous amendments to the FMP. The management matrix in Amendment 13 is designed to achieve impact rates, not escapement goals. Trigger points in the matrix are based upon observed parental spawner performance and indicators of marine survival rather than on inaccurate and imprecise preseason forecasts. Management is also based upon the parental spawner status of sub-aggregates hence provides protection for the weakest stocks in the overall OCN aggregate

While the STT, SSC, and IMST have acknowledged the obvious precautionary measures that have been incorporated into the management matrix in Amendment 13, they have still expressed concerns about the effectiveness of the matrix in managing OCN populations when either spawner abundance or marine survival are very low. However, there is no explicit link between either the allowable impacts in the matrix or the more conservative Council approved impact rates and population production models for OCN populations that have been experiencing both poor marine survival and "Very Low" or "Critical" spawner abundance. The PFMC has partially addressed these concerns by using discretionary authority to the keep fishery related impacts on OCN coho to levels well below the maximum allowable under the existing matrix. In fact, since 1998 when Amendment 13 went into effect, fishery impacts on OCN that were approved have been lower than required by the Amendment 13 and in 1999 and 2000 very nearly met requirements for "Critical" spawner status in the proposed new matrix (Table 6).

Allowing fishery impacts on OCN coho when a sub-aggregate of populations is in the "Critical" state of spawner abundance increases the risk of extinction. Model results indicate that any loss of spawning potential for OCN coho at this low level results in increased risk of extinction as a result of density dependent demographic effects. We have defined the parental spawner status of a sub-aggregate as "Critical" if the weighted average of spawner densities among basins in the sub-aggregate is less than or equal to four fish per mile. The only exception to this definition is in the Southern Sub-aggregate in which the Rogue River is the only major basin. Because of the disproportionately low level of high quality habitat to total habitat in that basin we have opted to define "Critical" spawner status as 12% of full seeding.

Production from spawners when abundance is in the "Critical" category is apt to be highly variable. At "Low" marine survival there is a fair certainty of low recruitment. At "Medium" or "High" marine survival the risk of very low recruitment continues but there is also a potential for recruitment to near full seeding levels. In the latter case, post-season estimated returns would be large but managers would make a pre-season determination to constrain the fisheries based upon parental spawner abundance being in the "Critical" category. Hindsight, in this instance, might indicate that fisheries could have been less constrained without detriment to the population. Nevertheless, fishery

Return Year	Management Matrix	Parent Spawner Level	Marine Survival	Maximum Allowable Impacts	Fishery Impacts	
					Preseason Modeling	Postseason Estimate
1998	Original	Very Low	Low	10-13 %	11.9%	7.8%
	Proposed	***Very Low***	***Extremely Low***	***8%***		
1999	Original	Very Low	Medium	15%	8.7%	7.6%
	Proposed	***Critical***	***Low***	***0-8%***		
2000	Original	Very Low	Medium	15%	8.2%	NA
	Proposed	***Critical***	***Low***	***0-8%***		
2001	Original	Very Low	Low to High	10-13% - 15%	NA	NA
	Proposed	***Critical***	***Low to High***	***0-8%***		
2002	Original	Low	Low to High	15%	NA	NA
	Proposed	***Low***	***Extremely Low to High***	***8-25%***		

Table 6. Comparison of current management matrix in Amendment 13 to the proposed new matrix with respect to how parental spawner and marine survivals are categorized and fishery impacts allowed. Comparisons are for return years 1998 through 2002 and include available pre-season modeled and post-season estimated impacts for 1998-2000years.

30

constraints that managers would implement based upon a pre-season assessment of "Critical' parental spawner status would be appropriate and justified based upon the probable risk to the population if greater fishery impacts were permitted.

In the existing management matrix, if a major basin in a sub-aggregate fails to achieve 10% of full seeding, advancement to a higher harvest level is not permitted, even if the parental spawner criteria for the next tier are met for the sub-aggregate as a whole. This particular safeguard has not been included in the proposed new matrix. The reasons for this change are threefold. First, SRS estimates of spawner abundance lack the precision required at the basin level to make a determination that spawner abundance in the basin is "Critical". Second, application of extremely conservative management measures for a coastwide fishery based upon imprecise estimates of performance of a population in one basin may have little effect upon recovery of a sub-aggregate of stocks or on OCN as a whole. Performance within one basin can result from very localized events such as flooding that may not accurately reflect the performance of the entire sub-aggregate. Third, the application of extremely conservative harvest rates to both the "Critical" and "Very Low" spawner abundance categories regardless of marine survival provides adequate protection for sub-aggregates and eliminates some of the necessity for the major basin criteria in the existing matrix.

The second state describes a population that is stable but not in recovery and fishery impacts when the population is in this state should be minimized at a very low level. In the previous matrix the Council was given the discretion of maintaining fishery impacts at some level less than 10-13% when the population was in this state. The new matrix limits fishery impacts in this category to 8% regardless of spawner abundance. Modeling results indicate that at an 8% impact rate the population can at least replace itself when marine survival is "Extremely Low" and parental spawners are "Very Low". Limiting fishery impacts to 8% when marine survival is "Extremely Low" but parental spawner abundance is greater than "Very Low" does not result in increased recruitment because of density dependent effects during freshwater rearing but is warranted as a precautionary measure.

Although boundaries for "Low" and "Medium" marine survival categories have changed slightly in the new matrix, harvest rates for those categories when parental spawners are in the "Low" and "Medium" categories are the same as the corresponding cells in the existing matrix. Modeling the "Low", "Medium", and "High" marine survival categories in the new matrix allows for slightly higher fishery impact rates at "High" parental spawner abundance and show the benefits of maintaining adequate spawning populations and the potential productivity of OCN coho when marine survival is high. However, it should be noted that years in the "High" marine survival category are a rare event. Most years will probably fall in the "Low" and "Medium" categories.

In conclusion, the proposed new matrix implements more conservative allowable fishery impacts rates at very low levels of spawner abundance and marine survival and slightly higher rates when conditions of spawner abundance and marine survival are favorable. All of the results are based upon output from the Nickelson and Lawson habitat based production model. One of the key assumptions of the model is that the status of freshwater spawning and rearing habitat is stable. Hence modeling results and the predicted probabilities for recovery of OCN coho are explicitly linked to the maintenance or increased availability of high quality freshwater habitat. If the quantity or quality of available freshwater habitat decreases further it is unlikely that any harvest management at low level of spawner abundance will result in stable or increasing OCN abundance.

RECOMMENDATIONS

Based upon the results of our analyses the consensus of the OCN Work Group is that the following changes to the management matrix in Amendment 13 will reduce the risk of extinction and improve the likelihood of recovery for OCN coho:

- Add "Critical" and "Very Low" parental spawner categories to the matrix. "Critical" is defined as spawner densities less than four fish per mile in the Northern, North-Central, and South Central sub-aggregates, and as less than 12% of full seeding in the Southern sub-aggregate. "Very Low" is defined for each sub-aggregate as greater than "Critical' but less than 19% of full seeding.
- Retain the "Low", "Medium" and "High" parental spawner categories as defined in the existing matrix (i.e. >19% and ≤50% of full seeding, >50% and ≤75% of full seeding, and >75% of full seeding, respectively).
- Eliminate the provision that prevents moving to a higher harvest rate based upon one major basin having less than 10% of full seeding.
- Define the spawner abundance status of OCN coho based upon the status of the weakest sub-aggregate as determine by the aforementioned criteria.
- Add a new "Extremely Low" marine survival category that has an OPI hatchery jacks:smolts ratio of less than 0.0008.
- Re-define the "Low" and "Medium" survival categories. OPI hatchery jacks:smolts ranges that define the two categories should be 0.0008 to 0.0014 and greater than 0.0014 to 0.0040 respectively.
- Retain the existing "High" marine survival definition as an OPI hatchery jacks:smolts ratio greater than 0.0040.
- Adjust allowable fishery impact rates in the matrix consistent with results of the Nickelson/Lawson habitat based production model.

REFERENCES

Bilby, R.E., B.R. Fransen, P.A.Bisson, J.K. Walter. 1998. Response of juvenile coho salmon (*Oncorhynchus kisutch*) and steelhead (*Oncorhynchus mykiss*) to the addition of salmon carcasses to two streams in southwestern Washington. Can. J. Fish. Aquat. Sci. 55:1908-1918.

Cederholm, C.J., D.H. Johnson, R.E. Bilby, L.G. Dominguez, A.M. Garrett, W.H. Graeber, E.L. Greda, M.D. Kunze, B.G. Marcot, J.F. Palmisano, R.W. Plotnikoff, W.G. Pearcy, C.A. Simenstad, and P.C. Trotter. 2000. Pacific Salmon and Wildlife-Ecological Contexts, Relationships, and Implications for Management. Special Edition Technical Report, Prepared for D.H. Johnson and T.A. O'Neil (Manag. Dirs.), Wildlife-Habitat Relationships in Oregon and Washington. Washington Department of Fish and Wildlife, Olympia.

IMST. 1999. Defining and evaluating recovery of OCN coho salmon stocks: Implications for rebuilding stocks under the Oregon Plan. Technical Report 1999-2, a report of the Independent Multidisciplinary Science Team, Oregon Plan for Salmon and Watersheds. Salem, Oregon.

Lynch, M. 1990. Mutation load and the survival of small populations. Evolution **44**:1725-1737.

McElhaney, P., M.H. Ruckelshaus, M.J. Ford, T.C. Wainwright, and E.P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-42, 156 p.

Nickelson, T.E. 1986. Influences of upwelling, ocean temperature, and smolt abundance on marine survival of coho salmon (*Oncorhynchus kisutch*) in the Oregon production Area. Can. J. Fish. Aquat. Sci. **43**: 527-535.

Nickelson, T.E. and P. Lawson. 1998. Population viability of coho salmon *Ocorhynchus kisutch*, in Oregon coastal basins: Application of a habitat-based life-cycle model. Can. J. Fish. Aquat. Sci. **55**: 2383-2392.

ODFW and NMFS. 1998. Final assessment of risk associated with the harvest management regime of the Thirteenth Amendment to the Pacific Coast Salmon Plan. Pacific Fishery Management Council. Portland, Oregon.

PFMC. 1999. Final Amendment 13 to the Pacific Coast Salmon Plan. Fishery management regime to ensure protection and rebuilding of Oregon coastal natural coho. Pacific Fishery Management Council. Portland, Oregon.

Seiler, D. 1989. Differential survival of Grays Harbor basin anadromous salmonids: water quality implications. *In* Proceedings of the National Workshop of Effects of Habitat Alteration on Salmonid Stocks. *Edited by* C.D. Levings, L.B. Holtby, and M.A. Henderson. Can. Spec. Publ. Fish. Aquat. Sci. No. **105**: 123-135.

Waples, R.S. 1990. Conservation genetics of Pacific salmon. II. Effective population size and rate of loss of genetic variability. J. Heredity **81**:267-276.

Appendix 1. A timeline for meetings, work assignments, progress reports, and a final report for the OCN work group that is completing a year 2000 review of Amendment 13 to the Pacific Fishery Management Council Salmon Management Plan.

Nov. 1999	PFMC appoints OCN work group.
Dec. 1999:	Initial meeting of work group. - Identify key issues. - Biological (e.g. spawning escapement requirements). - Methodological (e.g. review of habitat production model). - Procedural (e.g. practical implementation of Plan Amendment 13). - Incorporate results of Aug. 1999 IMST workshop on definition of recovery and criteria for assessing recovery of OCN coho. - Initial work assignments.
Dec. 1999 – Feb. 2000:	Data compilation and model review.
Mar. 2000:	Progress report to SSC, PFMC, and IMST.
Mar. – Jun. 2000:	Continuation of data analysis.
Jun. 2000:	Progress report to SSC and IMST.
Jun. – Sep. 2000:	Data analysis and report writing.
Sep. 2000:	Preliminary report to SSC, PMFC, and IMST.
Sep. – Nov. 2000:	Revisions and final edits to report.
Nov. 2000:	Final report to SSC, PFMC, and IMST.

Appendix 2. List of meeting dates and attendees for the ad hoc OCN work group that was approved by the PFMC in November 1999.

Designated Work Group Attendees					
	Meeting Dates and Attendance Lists				
Affiliation	Dec. 17, 1999	Apr. 28, 2000	Jun. 13, 2000	Aug. 1, 2000	Oct. 3, 2000
PFMC Staff	Dr. J Coon	Dr. J. Coon	Dr. J. Coon	Dr. J. Coon	Dr. J. Coon
NMFS / SSC	Dr. P. Lawson	Dr. P. Lawson	Dr. P. Lawson	Dr. P. Lawson	Dr. P. Lawson
NMFS / STT	(remote)		Dr. R. Kope	Dr. R. Kope	Dr. R. Kope
ODFW / OPITT	C. Melcher	C. Melcher	C. Melcher	C. Melcher	C. Melcher
ODFW Staff	S. Sharr	S. Sharr	S. Sharr	S. Sharr	S. Sharr
ODFW Staff	T. Nickelson	T. Nickelson	T. Nickelson	T. Nickelson	T. Nickelson
	Advisory Attendees				
IMST	Dr. B. Pearcy	Dr. B Pearcy	Dr. S. Gregory		Dr. S. Gregory
IMST	Dr. S. Gregory				
NMFS Staff		Dr. T. Wainwright			
ODFW Staff		Dr. B. Mcintosh	M. Chilcote		M. Burner

36

Appendix 3. Proposed harvest management matrix for Plan Amendment 13 showing allowable fishery impacts and range of expected resulting spawner populations.

Parent Spawner Status [1/]			Marine Survival Index (based on return of jacks per hatchery smolt)							
Category	Seeding Levels		Extremely Low (<0.0008)		Low (0.0008 to <0.0015)		Medium (0.0015 to <0.0040)		High (≥0.0040)	
	Low End	High End								
High	> 75% of Full Seeding		E ≤ 8%		J ≤ 15%		O ≤ 30%		T ≤ 45%	
	99,075	132,100	33,000	107,000	58,000	135,000	123,000	259,000	187,000	284,000
Medium	>50% & ≤75% of Full Seeding		D ≤ 8%		I ≤ 15%		N ≤ 20%		S ≤ 38%	
	66,050	99,075	29,000	96,000	51,000	123,000	123,000	268,000	185,000	291,000
Low	>19% & ≤50% of Full Seeding		C ≤ 8%		H ≤ 15%		M ≤ 15%		H ≤ 25%	
	25,099	66,050	21,000	84,000	37,000	107,000	95,000	250,000	162,000	308,000
Very Low	> 4 Fish per Mile & ≤19% of Full Seeding		B ≤ 8%		G ≤ 11%		L ≤ 11%		Q ≤ 11%	
	15,852	25,099	18,000	61,000	33,000	82,000	88,000	190,000	165,000	265,000
Critical [2/]	≤ 4 Fish per Mile		A (0-8%)		F (0-8%)		K (0-8%)		P (0-8%)	
	99,075	132,100	Unknown		Unknown		Unknown		Unknown	
Survival Rates			Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Observed Hatchery			0.46%	1.28%	1.11%	2.39%	2.95%	8.40%	8.53%	11.68%
Estimated Wild			0.90%	2.60%	1.70%	3.60%	4.40%	8.40%	8.53%	11.68%
Estimation Factor			2.0	2.0	1.5	1.5	1.5	1.0	1.0	1.0

Sub-aggregate and Basin Specific Spawner Criteria Data

Sub-aggregate	Miles of Available Spawning Habitat	100% of Full Seeding	"Critical"		Very Low, Low, Medium & High		
			4 Fish per Mile	12% of Full Seeding	19% of Full Seeding	50% of Full Seeding	75% of full Seeding
Northern							
Nehalem	NA	17,500	NA	NA	3,325	8,750	13,125
Tillamook	NA	2,000	NA	NA	380	1,000	1,500
Nestucca	NA	1,800	NA	NA	342	900	1,350
Ocean Tributaries	NA	400	NA	NA	76	200	300
Total	899	21,700	3,596	NA	4,123	10,850	16,275
North - Central							
Siletz	NA	4,300	NA	NA	817	2,150	3,225
Yaquina	NA	7,100	NA	NA	1,349	3,550	5,325
Alsea	NA	15,100	NA	NA	2,869	7,550	11,325
Siuslaw	NA	22,800	NA	NA	4,332	11,400	17,100
Ocean Tributaries	NA	5,700	NA	NA	1,083	2,850	4,275
Total	1,163	55,000	4,652	NA	10,450	27,500	41,250
South - Central							
Umpqua		29,400	NA	NA	5,586	14,700	22,050
Coos		7,200	NA	NA	1,368	3,600	5,400
Coquille		5,400	NA	NA	1,026	2,700	4,050
Coastal Lakes		8,000	NA	NA	1,520	4,000	6,000
Total	1,685	50,000	6,740	NA	9,500	25,000	37,500
Southern							
Rogue River	450	5,400	NA	648	1,026	2,700	4,050
Total	450	5,400	NA	648	1,026	2,700	4,050
Coastwide Total	4,197	132,100	15,636		25,099	66,050	99,075

1/ Parental spawner abundance status for the OCN aggergate assumes the status of the weakest sub-aggregate.

2/ "Critical" parental spawner status is defined as 4 fish per mile for the Northern, North-Central, and South-Central subaggergates. Because the ratio of high quality spawning habitat to total spawning habitat in the Rogue River Basin differs significantly from the rest of the basins on the coast, the spawner density of 4 fish per mile does not represent "Critical" status for that basin. Instead. "Critical" status for the Rogue Basin (Southern Sub-aggergate) is estimated as 12% of full seeding of high quality habitat.