Exhibit E.2.b
Supplemental Work Group Report
September 2000

STATUS UPDATE ON THE 2000 REVIEW OF AMENDMENT 13 TO THE PACIFIC COAST SALMON PLAN

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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, the pre-season outlook for OPI coho returns was very poor but contrary to expectations, the return of the Columbia River hatchery component of the OPI was one of the largest ever recorded. Unfortunately, on the basis of the pre-season forecast, the Council had established minimal ocean fisheries in 1986 to insure that the MSY escapement goal for OCN coho was met. Because the Council 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 goal was 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 abundance from inaccurate forecasting models, management actions in Amendment 13 are triggered by actual brood year specific parental spawner abundance and juvenile

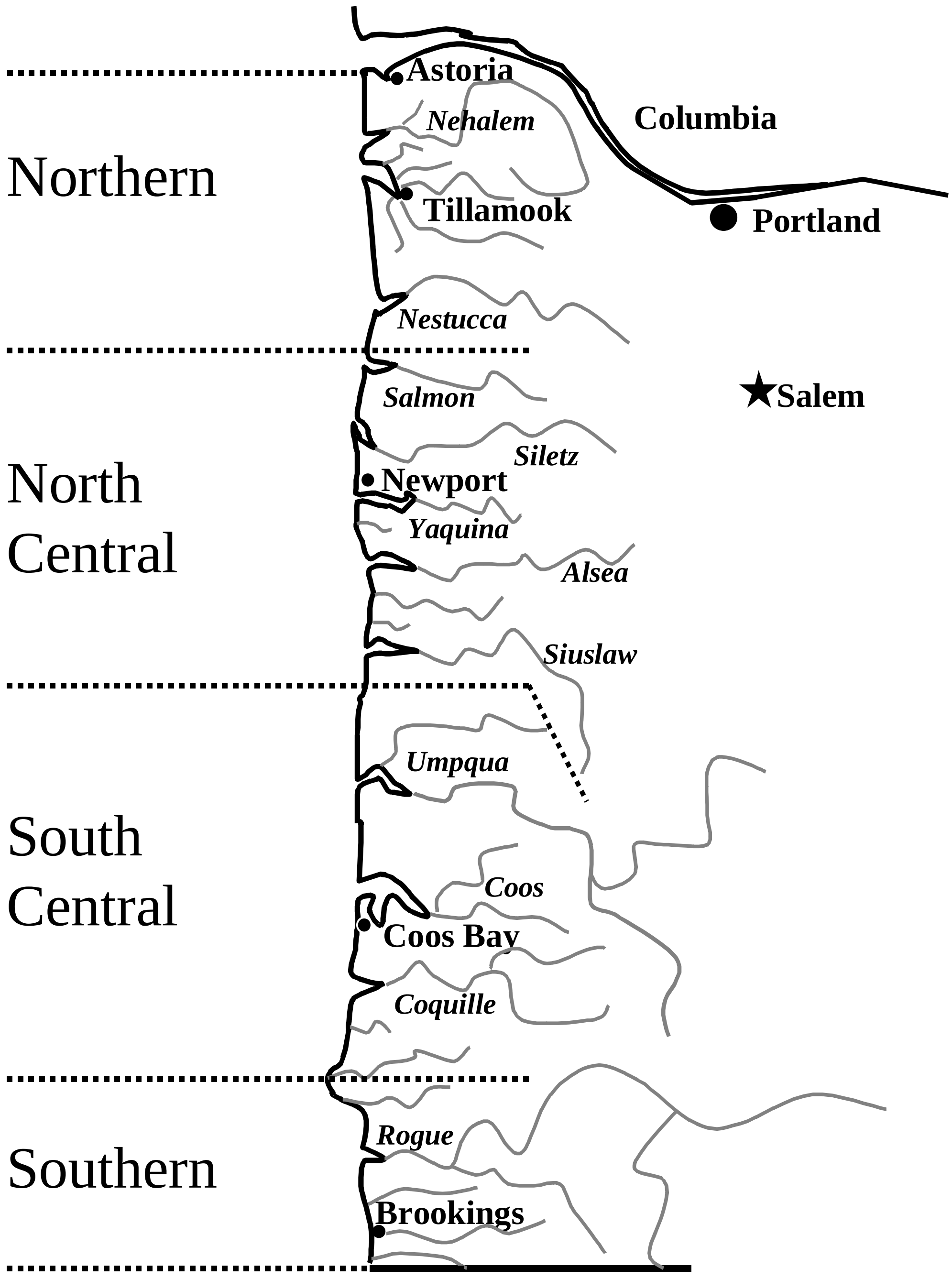

Figure 1. Map of the Oregon Coast showing major river basins that produce OCN coho and the sub-aggregate grouping of those basins.

survival observations (Table 1). The Pacific Fishery Management Council approved amendment 13 to the FMP in November 1997 (PFMC 1997).

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 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

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

ALLOWABLE TOTAL FISHERY EXPLOITATION RATES FOR OCN STOCK COMPONENTS			
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* grand parent 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%**	**≤ 15%**	**≤ 15%**
Parent spawners less than 38% of level 1 rebuilding criteria	**≤ 10-13%** [c]		

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 survival as estimated from measured smolt to jack survival for OPI coho.

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.

c/ This impact 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 1994-95 (i.e. < 0.06% hatchery smolt to jack survival) 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 Council 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

Recalibrated 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 (1999) 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:

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

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:

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

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 (Cedarholm, 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 model developed by Nickelson and Lawson (1998) that was previously applied to the risk assessment analysis of Amendment 13.

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. There was no fishery mortality modeled. All coastal basins were modeled, and 1,000 iterations of the model were run.

In order 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 zero 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 and maximum yield from 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 relatively good (Figure 2). 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" - The upper bound of the category is the marine survival at which populations fail to replace themselves regardless of spawner abundance.

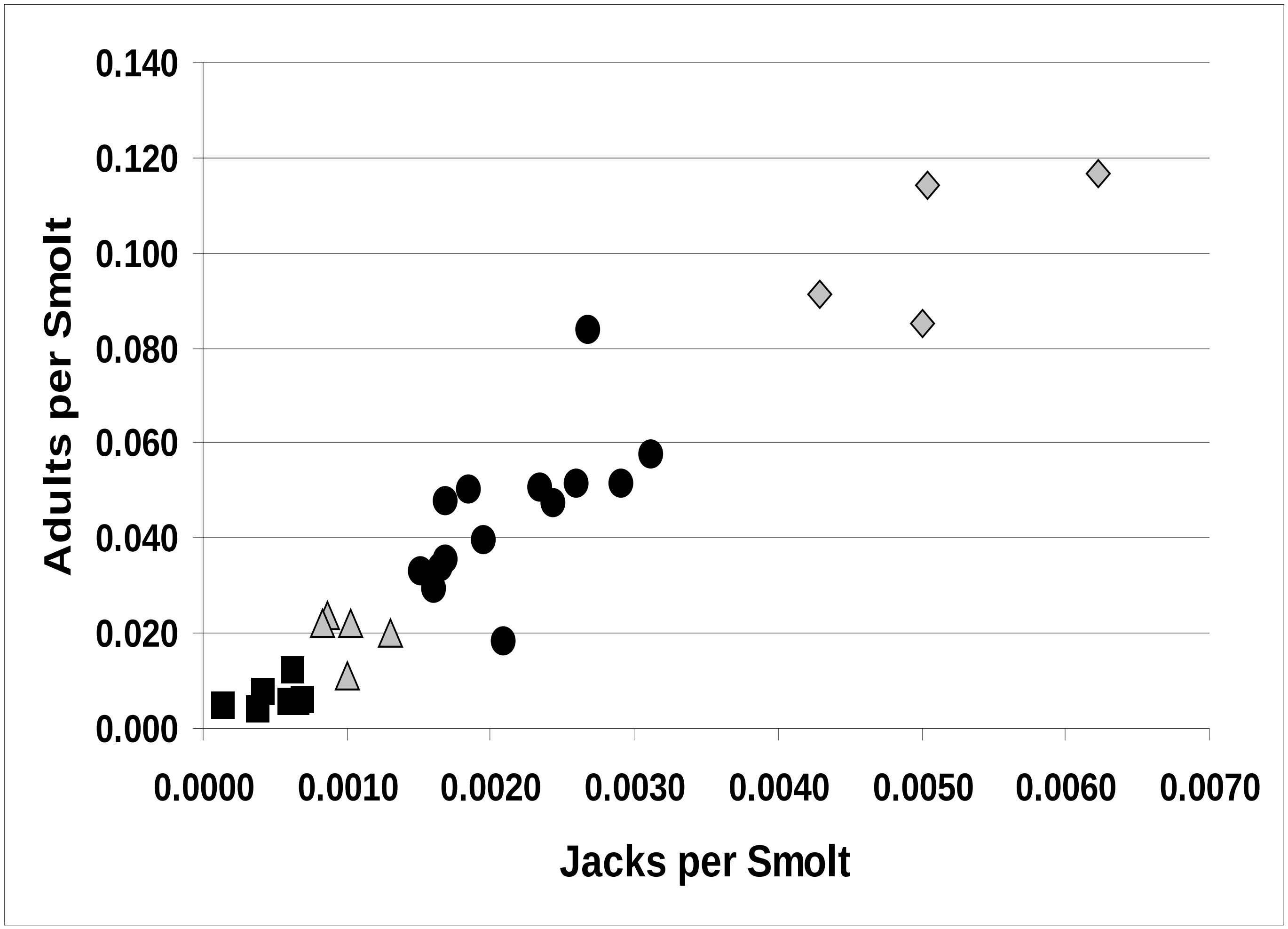

Figure 2. Relationship of jack:smolt versus adult:smolt ratios for OPI hatchery coho (the four different shaded symbols represent the four new marine survival categories in the revised harvest management matrix).

"Low" - The range of marine survivals that result in populations that stabilize at about 50% of full seeding. At low spawner abundance the reduced density dependent effects in freshwater rearing areas compensate for low abundance and recruits per spawner are greater than one. However, as spawner abundance increases, density dependent effects begin to exert negative affects on freshwater productivity and recruitment declines.

"Medium" - When marine survivals are in this category the population, on average, experiences recruitment >1 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" - The High survival 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.

Establishing Fishery Exploitation Rates

Minimum and maximum populations expected to result from application of the matrix were calculated for each cell using the Deterministic Model described above. The low range of expectations for each cell is based on the combination of its maximum allowable harvest impact, its minimum parent spawner population, and its minimum expected marine survival rate. The high range of expectations for each cell is based on the combination of its maximum allowable harvest impact, its maximum parent spawner population and its maximum expected marine survival rate.

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. Moreover, an average of more than 20% of all major basins had escapements less than 10% of full seeding, an average of 40% were at less than 38% of Level 1 (19% of full seeding), and an average of two thirds were below Level 1 (50% of full seeding). In the most recent three brood cycles (parent years 1997, 1998, and 1999), more than

40% of all major basins in 1997 and 1998 had spawner densities at critical levels of less than 10% of full seeding and more than half 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 experienced by the 1991-93 brood cycles (1994-96 adult returns) were classified as "extremely low". Marine survival remained in the "extremely low" category for fish produced from the 1994 and 1995 brood cycles but improved to the lower end of the "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 4). Poor spawner to recruitment ratios are evident among all subaggregates (Figure 5). 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 jack:smolt 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 can 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 jack:smolt ratios of <0.08% (Table 2). 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.

"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 by jack:smolt ratios of 0.08-0.14%. Under the conditions of this category, it is expected that marine survival of hatchery fish will range from 1% to possibly 3%. Marine survival

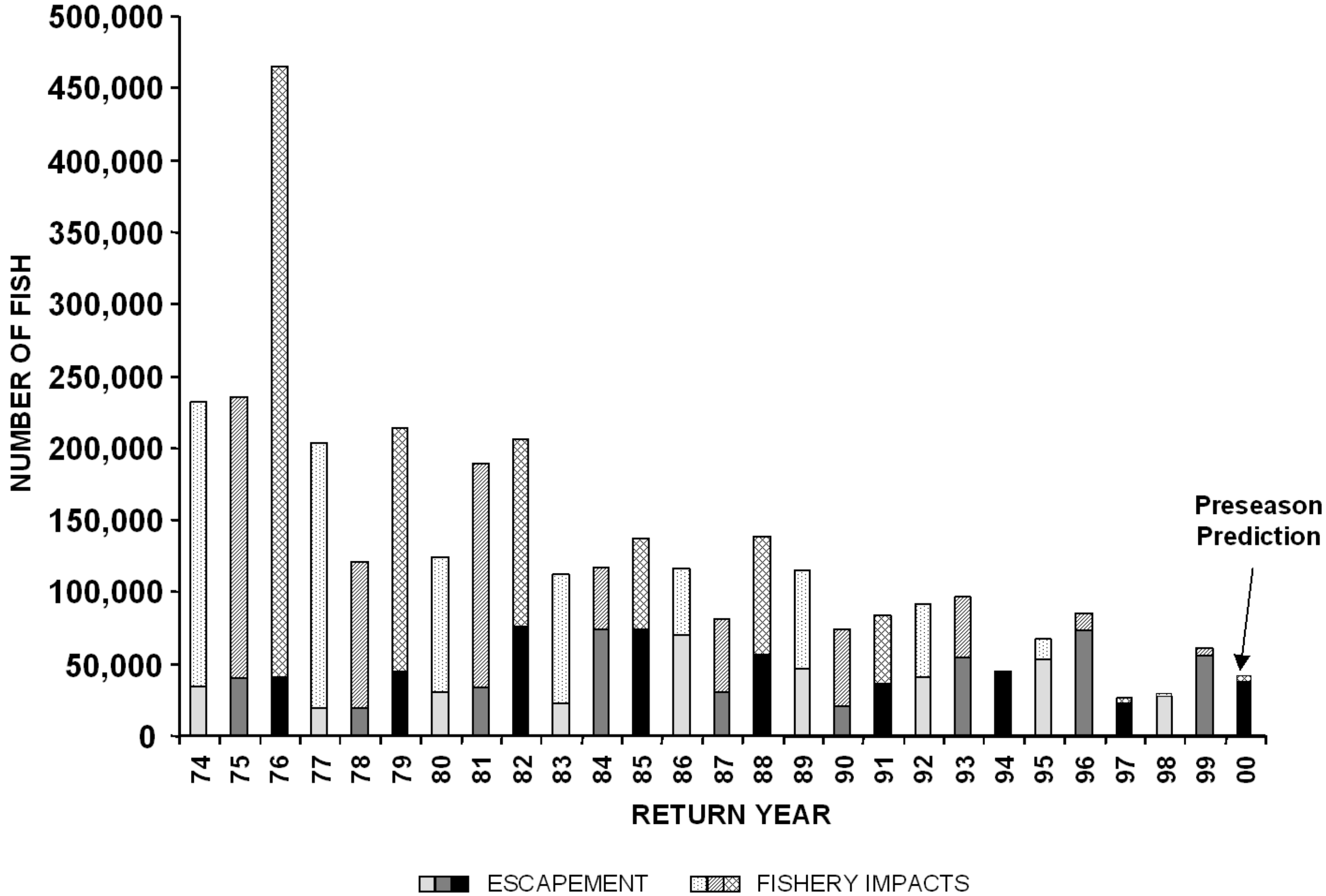

Figure 3. Total annual pre-fishery ocean population size of adult OCN coho. The population for each return year is shown as a stacked bar with hatched portions depicting fishery related impacts and solid portions depicting spawning escapement. The cohorts originating from the 1971, 72, and 73 brood cycles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

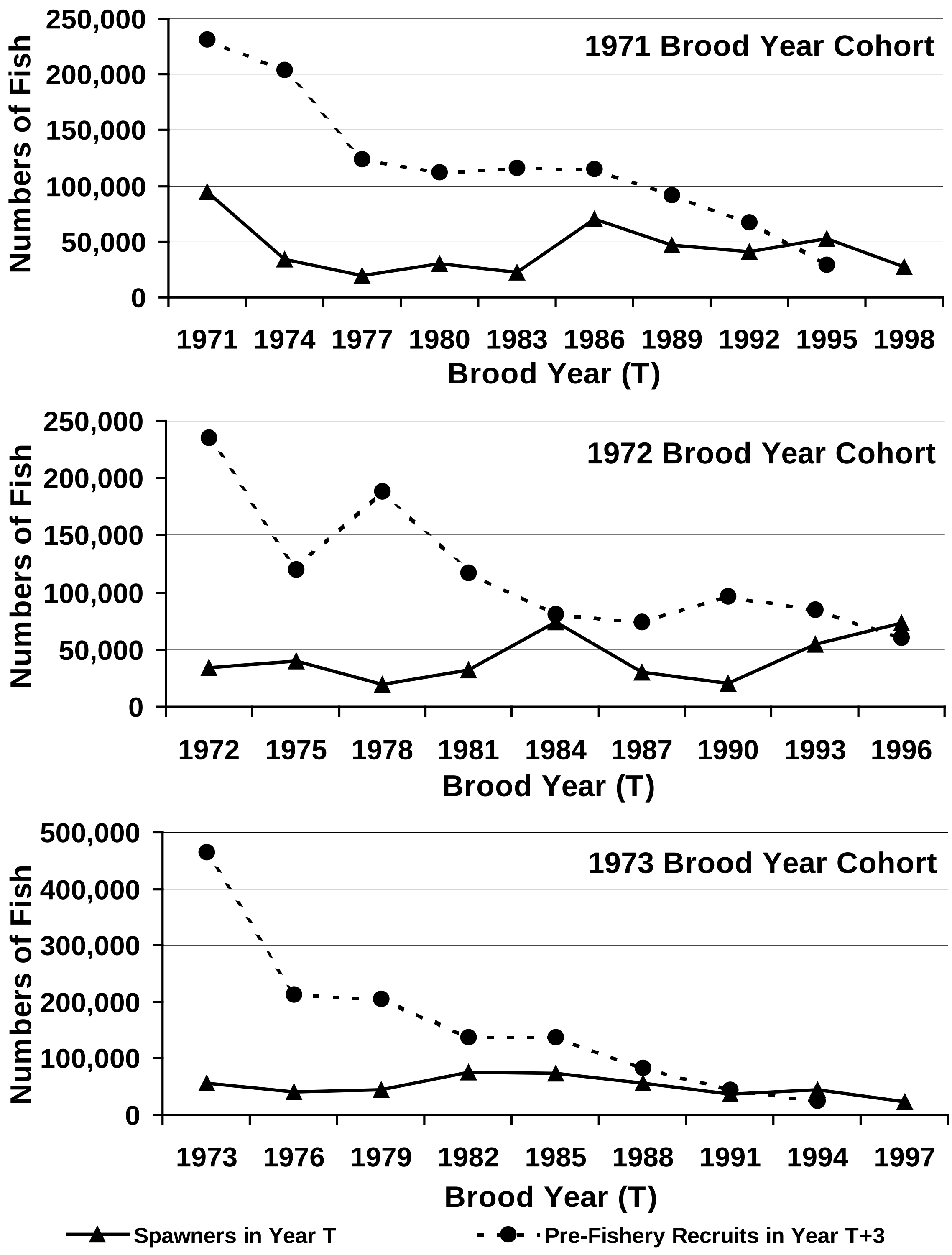

Figure 4. Annual parental spawners and resulting pre-fishery recruits for the cohorts originating from the 1971, 72, and 73 brood cycles.

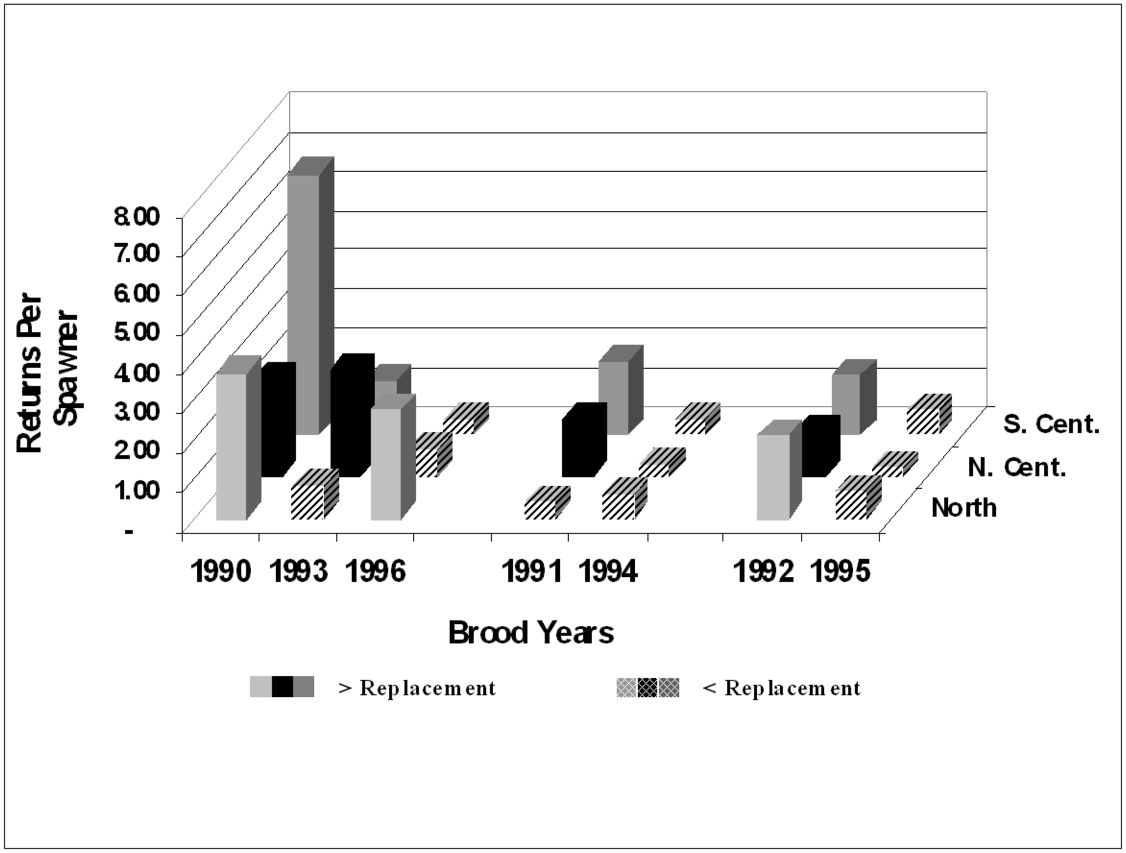

Figure 5. Returns per spawner for OCN coho sub-aggregates for the 1990, 91, and 92 brood cycles. Hatched bars indicate returns per spawner of less than one (failure to replace).

Year (t)	Smolts (t-1)	Jacks (t-1)	Jacks/Smolt	Adults (t)	Adults/Smolt		Adults/Smolt
	HIGH ADULT MARINE SURVIVAL						
	(Predicted by Smolt-to-Jack Survival ≥0.40%)						
1971	28.8	179.4	0.62%	3365.0	11.7%		
1976	34.0	171.5	0.50%	3885.3	11.4%	Average	10.2%
1970	32.4	162.2	0.50%	2765.1	8.5%	Maximum	11.7%
1974	33.6	144.2	0.43%	3071.1	9.1%	Minimum	8.5%
	MEDIUM ADULT MARINE SURVIVAL						
	(Predicted by Smolt-to-Jack Survival of 0.15-0.39%)						
1972	33.3	103.7	0.31%	1924.8	5.8%		
1978	35.5	103.2	0.29%	1824.1	5.1%		
1986	29.0	77.6	0.27%	2435.8	8.4%		
1973	35.3	91.4	0.26%	1817.0	5.1%		
1988	35.0	85.1	0.24%	1666.1	4.8%		
1975	32.6	76.2	0.23%	1652.8	5.1%		
1983	32.7	68.2	0.21%	595.7	1.8%	El Nino	
1979	37.1	72.5	0.20%	1476.7	4.0%		
1991	37.2	68.7	0.18%	1874.8	5.0%		
1989	36.0	60.8	0.17%	1721.4	4.8%		
1980	34.2	57.6	0.17%	1224.0	3.6%		
1982	37.3	61.3	0.16%	1266.8	3.4%	Average	4.5%
1977	33.5	53.7	0.16%	987.5	2.9%	Maximum	8.4%
1981	32.3	48.7	0.15%	1064.5	3.3%	Minimum	2.9%
	LOW ADULT MARINE SURVIVAL						
	(Predicted by Smolt-to-Jack Survival of 0.08-0.14%)						
1990	35.9	46.7	0.13%	718.4	2.0%		
1984	30.9	31.7	0.10%	689.4	2.2%		
1999	29.1	29.1	0.10%	322.4	1.1%	Average	2.0%
1985	30.0	26.0	0.09%	717.5	2.4%	Maximum	2.4%
1987	39.5	32.8	0.08%	880.1	2.2%	Minimum	1.1%
	EXTREMELY LOW ADULT MARINE SURVIVAL						
	(Predicted by Smolt-to-Jack Survival ≤0.08%)						
1993	39.7	27.2	0.07%	261.7	0.7%		
1997	31.6	20.4	0.06%	197.2	0.6%		
1992	42.1	25.6	0.06%	540.8	1.3%		
1996	29.5	17.3	0.06%	184.9	0.6%		
1998	24.6	9.8	0.04%	202.6	0.8%	Average	0.7%
1995	32.3	11.8	0.04%	147.1	0.5%	Maximum	1.3%
1994	39.5	5.1	0.01%	202.4	0.5%	Minimum	0.5%

Table 2. 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.

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 0.15-0.39%. 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 ≥0.40%. For modeling purposes, it was assumed that marine survival of wild fish in this category would be the same as that of hatchery fish.

Parental Spawner Categories

"Critical" Parental Spawner Density

Results were consistent across basins. Larger basins, and basins with higher quality habitat, showed overall lower extinction probabilities, as expected. But all basins showed an exponential increase in extinction probability with declining spawner densities. The probabilities all trended higher below densities of 3 to 5 fpm. Because the response of all basins was so similar, we combined the results across all basins to arrive at a single curve which expresses the probability of extinction in four generations as a function of spawner density (Figure 6).

As with all model results, this curve 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

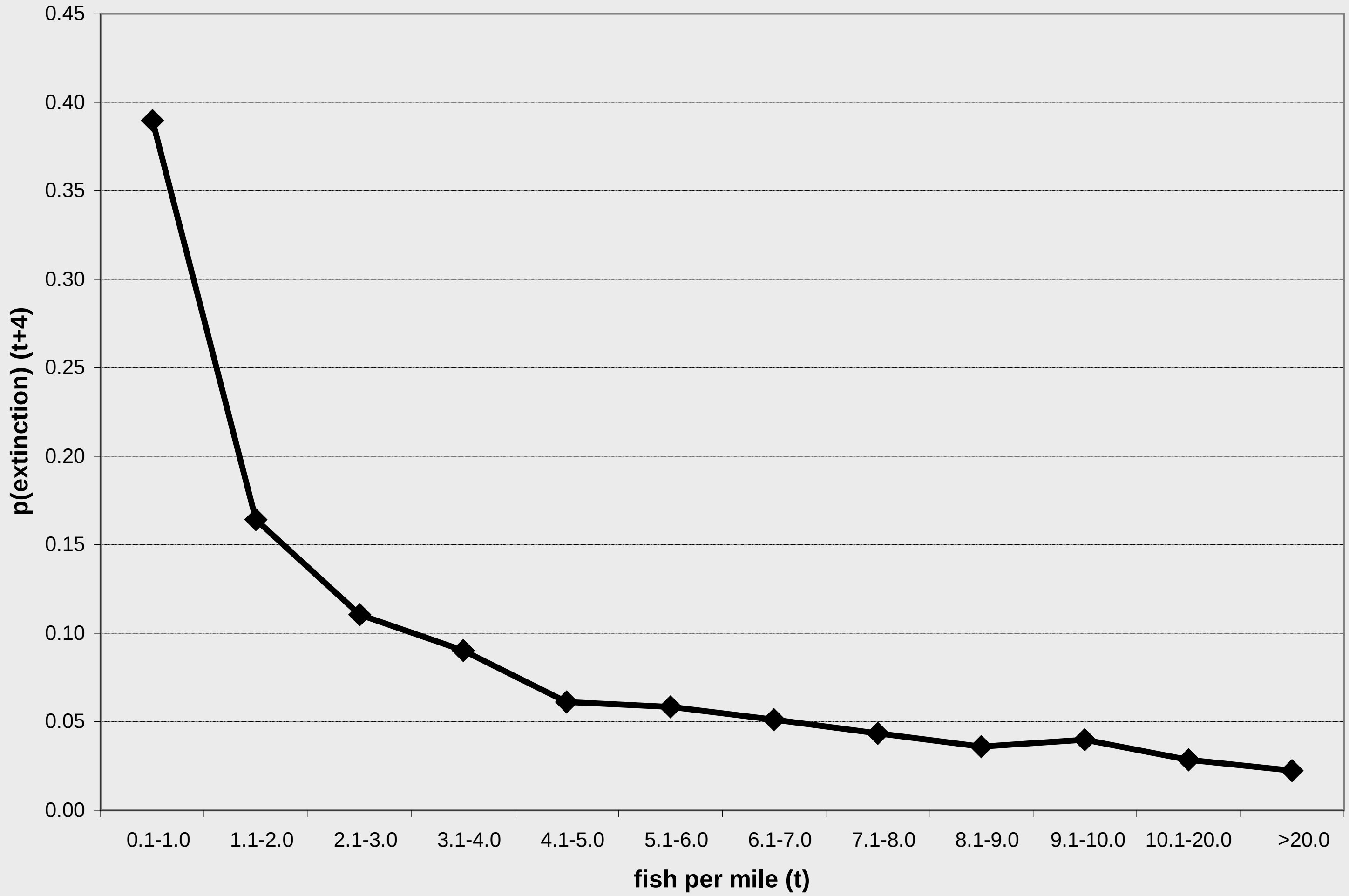

Figure 6. Probability of basin-level extinction in 4 generations as a function of spawner density. All Oregon coastal basins are combined.

important is the shape of the curve: as populations drop below about 5 fpm the risk of extinction starts to rise rapidly.

"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 grand parental spawners.

Fishery Impact Rates

A harvest management matrix that incorporates new marine survival and spawner abundance categories is shown in Table 3. 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.

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

From a biological perspective, a population with parental spawner abundance in this category should not been subjected to fishery related impacts at all. Risk of extinction for a population in this category increases rapidly because of demographic effects such as two spawners not being able to find each other. Under these conditions, impacts other than natural mortality may significantly 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 significantly increase the risk of extinction for the population and are not prudent or biologically justifiable. For this reason, we have opted to show no harvest related impacts for the cells in this category.

"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 is 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

Table 3. 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.

Parent Spawner Status		Marine Survival Index (based on return of jacks per hatchery smolt)							
Category	% Full Seeding	Extremely Low		Low		Medium		High	
Low End	High End	(<0.0008 jacks/smolt)		(0.0008 to 0.0014)		(0.0015 to 0.0039)		(>0.0040 jacks/smolt)	
High	**>75**	**E**	**≤ 7%**	**J**	**≤ 15%**	**O**	**≤ 30%**	**T**	**≤ 45%**
99,075	**132,100**	**34,000**	**107,000**	**58,000**	**135,000**	**123,000**	**259,000**	**187,000**	**284,000**
Medium	**>50-75**	**D**	**≤ 7%**	**I**	**≤ 15%**	**N**	**≤ 20%**	**S**	**≤ 38%**
66,050	**99,075**	**29,000**	**97,000**	**51,000**	**123,000**	**123,000**	**268,000**	**185,000**	**291,000**
Low	**>19-50**	**C**	**≤ 7%**	**H**	**≤ 15%**	**M**	**≤ 15%**	**R**	**≤ 25%**
25,099	**66,050**	**21,000**	**85,000**	**37,000**	**107,000**	**95,000**	**250,000**	**162,000**	**308,000**
Very Low	**>12-19**	**B**	**≤ 7%**	**G**	**≤ 11%**	**L**	**≤ 11%**	**Q**	**≤ 11%**
15,852	**25,099**	**18,000**	**62,000**	**33,000**	**82,000**	**86,000**	**190,000**	**165,000**	**265,000**
Critical	**<4 fsh/m**	**A**		**F**		**K**		**P**	
	15,852	**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		**0.9%**	**2.6%**	**1.7%**	**3.6%**	**4.4%**	**8.4%**	**8.5%**	**11.7%**
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

Sub- Aggregate/ Basin	Critically Low Spawner Densities	Rebuilding Levels (Number of Spawners)		
		50% of Full Seeding	75% of Full Seeding	Full Seeding
Northern				
Nehalem	2,100	8,750	13,125	17,500
Tillamook	240	1,000	1,500	2,000
Nestucca	216	900	1,350	1,800
Ocean Tributaries	48	200	300	400
Total	2,604	10,850	16,275	21,700
North Central				
Siletz	516	2,150	3,225	4,300
Yaquina	852	3,550	5,325	7,100
Alsea	1,812	7,550	11,325	15,100
Siuslaw	2,736	11,400	17,100	22,800
Ocean Tributaries	684	2,850	4,275	5,700
Total	6,600	27,500	41,250	55,000
South Central				
Umpqua	3,528	14,700	22,050	29,400
Coos	864	3,600	5,400	7,200
Coquille	648	2,700	4,050	5,400
Coastal Lakes	960	4,000	6,000	8,000
Total	6,000	25,000	37,500	50,000
South				
Rogue	648	2,700	4,050	5,400
Total	648	2,700	4,050	5,400
Coastwide Total	15,852	66,050	99,075	132,100

1/ The low end of the expected recruits in each cell is based on the combination of low end spawner abundance and low end marine survival of wild fish expected for the cell, except for "Critical" parental spawner status. In those cells, low end estimates were based on the combination of expected high parental spawner numbers and the minimum marine survival expected for the cell. The high range of expected recruitment in each cell is based on the combination of the high expected parental spawners and the high expected marine survival for the cell.

2/ The "Critical" parental spawner value is only estimated for the entire OCN aggregate and is 12% of full seeding.. The values shown for basins and subaggregates are approximated as 12% of their full seeding values.

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 7% 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 than have no directed take of wild or natural coho. Model results verify that fishery impacts of 7% 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 is "Low" marine survival category. The modification proposes to expand its application "Very Low " parental spawner abundance across the higher marine survival categories as a 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. The median spawner population in the "Medium" and "High" categories should fall 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. Near term Council management of ocean fisheries will likely continue to be constrained to areas of the management matrix defined by very low parental spawner abundance and marine survival. The SSC and the IMST have expressed 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 and 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 subaggregates and major basins hence provide 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. The Council has used discretionary authority to the keep fishery related impacts on OCN coho to levels well below the maximum allowable under the existing matrix. 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 newly proposed matrix in general describes OCN coho in three states of recovery:

1) A population, which fails to replace itself, even in the absence of fishery impacts. The population is in this state when it is in the "Critical" parental spawner category.
2) A population that stabilizes at approximately 50% of full seeding. This occurs when marine survival is "Extremely Low".
3) A population in recovery that is increasing or is at maximum productive capacity. This state encompasses all of the cells defined the intersection of the "Low", Medium", and "High" marine survival categories and for all parental spawner categories greater than "Critical".

The upper bounds for the "Critical" spawner abundance and "Extremely Low" marine survival categories are explicitly defined by results from stochastic and deterministic forms of the Nickelson and Lawson model and the intersection of these two categories is the anchor for the rest of the matrix.

By definition, there should be no allowable fishery related impacts when a population is in the "Critical" state of spawner abundance. Model results indicate that any loss of spawning potential for OCN coho at his low level results in a significant increase in the risk of extinction as a result of density dependent demographic effects. We have defined the parental spawner status of a subaggregate as being "Critical" if the status of at least one major basin within the subaggregate is "Critical". Therefore, since the categories in the matrix are defined by the status of the weakest subaggregate, if the status of the population in a major basin is "Critical" the parental spawner status in the matrix is defined as "Critical".

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 7% regardless of spawner abundance. Modeling results indicate that at a 7% 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 7% 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 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.

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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.

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			
	Dec. 17, 1999	Apr. 28, 2000	Jun. 13, 2000	Aug. 1, 2000
PFMC Staff	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
NMFS / STT	(remote)		Dr. R. Kope	Dr. R. Kope
ODFW /		C. Melcher	C. Melcher	C. Melcher
OPITT	C. Melcher	S. Sharr	S. Sharr	S. Sharr
ODFW Staff	S. Sharr	T. Nickelson	T. Nickelson	T. Nickelson
ODFW Staff	T. Nickelson			
Advisory Attendees				
IMST	Dr. B. Pearcy	Dr. B Pearcy	Dr. S. Gregory	
IMST	Dr. S. Gregory			
NMFS Staff		Dr. T. Wainwright		
ODFW Staff		Dr. B. Mcintosh	M. Chilcote	