PRELIMINARY DRAFT ENVIRONMENTAL ASSESSMENT
FOR
PACIFIC COAST SALMON PLAN AMENDMENT 15: AN INITIATIVE TO PROVIDE *DE MINIMIS* OCEAN FISHING OPPORTUNITY FOR KLAMATH RIVER FALL CHINOOK

INCORPORATING THE REGULATORY IMPACT REVIEW
AND
INITIAL REGULATORY FLEXIBILITY ANALYSIS

PREPARED BY
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COVER SHEET

PACIFIC COAST SALMON PLAN AMENDMENT 15: AN INITIATIVE TO PROVIDE FOR *DE MINIMIS* FISHING OPPORTUNITY FOR KLAMATH RIVER FALL-RUN CHINOOK SALMON ENVIRONMENTAL ASSESSMENT

Proposed Action:	Amend the Salmon FMP to allow minimal, or *de minimis*, fisheries in years when the KRFC conservation objective is projected not to be met. Alternatives are presented for determining a maximum harvest rate for KRFC that would be allowed under *de minimis* fisheries.
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Abstract:
This document analyzes the environmental and socioeconomic impacts of proposed amendment to the Pacific Coast Salmon Plan (Salmon Fishery Management Plan; FMP). The Pacific Fishery Management Council (Council) proposes to amend the Salmon FMP to allow limited harvest of Klamath River fall Chinook (KRFC) in ocean salmon fisheries during years that might otherwise be closed because of a projected shortfall in the KRFC conservation objective of 35,000 naturally spawning adults

EXECUTIVE SUMMARY

This document analyzes the environmental and socioeconomic impacts of proposed Amendment 15 to the Pacific Coast Salmon Plan (Salmon Fishery Management Plan; FMP), which is intended to allow limited harvest of Klamath River fall Chinook (KRFC) in ocean salmon fisheries during years that might otherwise be closed because of a projected shortfall in the KRFC conservation objective of 35,000 naturally spawning adults

The impetus for this initiative began in 2005 due to constraints to protect Klamath River fall-run Chinook salmon (KRFC) that reduced access to a projected high ocean abundance of Sacramento River fall-run Chinook salmon. The need was elevated in 2006 when projected low abundance of KRFC required that all directed ocean fisheries that impact KRFC should not open because the Pacific Fishery Management Council's (Council or PFMC) Salmon Fishery Management Plan (FMP) and National Marine Fisheries Service (NMFS) implementing rules did not allow for any level of minimal or incidental take when the projected stock abundance was less than 35,000 natural spawners (Conservation Alert Standard).

Emergency action was required to allow minimal impact on KRFC in directed ocean salmon fisheries between Cape Falcon, Oregon and Point. Sur, California in 2006 (71 FR 26254, May 4, 2006).

The purpose of this initiative was two-fold: (1) to give more flexibility to the rule-making process when the conservation objective for KFRC is projected not to be met; and (2) to provide for appropriate opportunities to access more robust Chinook salmon stocks that are typically available in the Council-managed area. This should allow for Council action without the need for NMFS to declare and approve an emergency rule.

This action was needed to prevent fishery restrictions that impose severe economic consequences to local communities and states. Historically, KRFC was a primary contributor to marine fisheries off the coasts of Oregon and California. While this amendment seeks to provide management flexibility in times of low KRFC abundance, there was an overriding purpose to preserve the long-term productive capacity of the stock to ensure meaningful contributions to ocean and river fisheries in the future.

The scope of the initiative was narrowed to potentially significant issues in Section 1.5. Biological and economic impact criteria were established to evaluate fishery alternatives, as follows:

1) Probability of a natural spawning escapement of <12,000 adults (lowest on record),
2) Probability of a natural spawning escapement in either the Shasta, Scott or Salmon rivers of <720 adults (stock diversity concern),
3) Probability of a Klamath Basin natural spawning escapement of <35,000 adults (Conservation Alert Standard),
4) Probability of 3 consecutive years of Klamath Basin natural spawning escapements of <35,000 adults (Overfishing Concern),
5) Probability of meeting hatchery egg-take goals,
6) Probability of meeting Endangered Species Act (ESA) Consultation Standard for threatened California Coastal Chinook (CCC) salmon,
7) Relative ocean recreational salmon fishery economic impacts,
8) Relative troll salmon fishery economic impacts,
9) Probability of meeting Tribal fishery subsistence needs (12,000 adults).
10) Relative Tribal commercial fishery economic impacts, and
11) Relative river recreational salmon fishery economic impacts.

The Status Quo Alternative was used as the base for comparison of the alternatives.

Under the Status Quo Alternative there would be no directed salmon fishing at or below the Conservation Alert Standard for KRFC. The other alternatives (fixed cap alternatives) provide for limited ocean salmon harvest opportunity by specifying maximum age-4 KRFC ocean fishery impact rates. An ocean impact rate includes landed fish and non-landed fishery-related mortalities (drop-offs and shakers). These rates may be used during a Conservation Alert year, but do not replace the conservation objective as a trigger for a Conservation Alert or Overfishing Concern. The alternatives and their stock abundance implementation thresholds (approximations), expressed in terms of naturally spawning adult fish are as follows:

1) Status Quo Alternative - 35,000 natural spawners (no fishing at or below this level)
2) 5% Cap Alternative - 40,000 natural spawners
3) 10% Cap Alternative - 46,700 natural spawners
4) 13% Cap Alternative - 51,900 natural spawners

This initiative does not modify the overall management plan for KRFC at abundance levels higher than the respective implementation thresholds. The Salmon FMP allows for an annual 67% spawner reduction rate, which is inclusive of impacts by ocean and river fisheries on age-3 to age-5 KRFC. However, the ESA Consultation Standard for CCC salmon sets the maximum ocean harvest rate for age-4 KRFC at 16% (equal to 17% age-4 ocean impact rate using historical ocean salmon fishery minimum size limits). Thus, the CCC salmon consultation standard currently sets the upper limit for KRFC ocean fishery impacts (Figure ES-1).

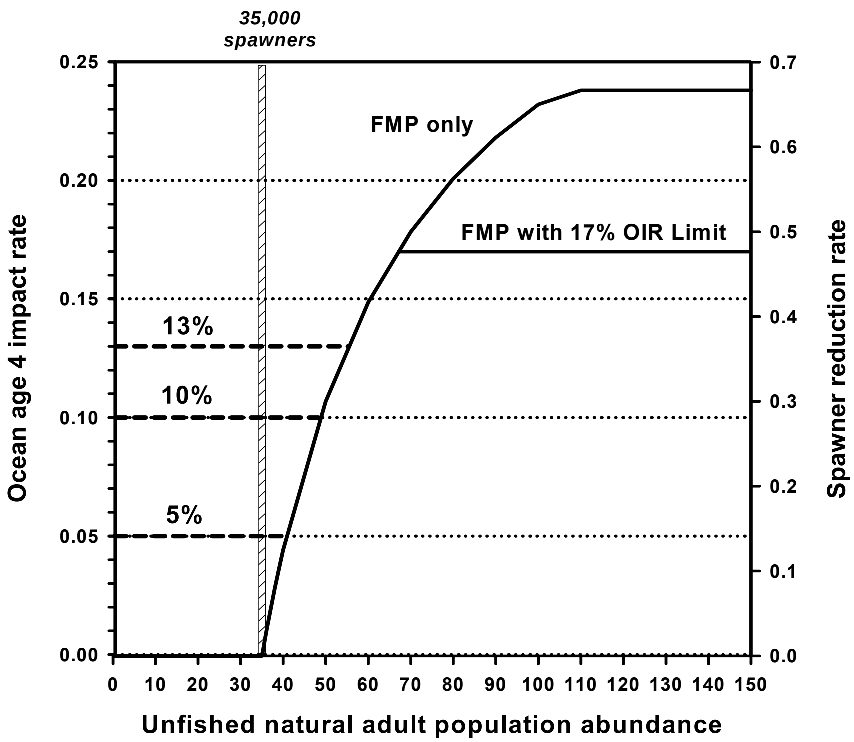

Figure ES-1. Implementation thresholds for *de minimis* fishing alternatives relative to FMP management and CCC standard (Status Quo Alternative).

Two approaches were used to analyze the biological effects of the Status Quo and *de minimis* fishery alternatives: 1) hypothetical pre-season implementation of the alternatives using 1985-2006 pre-season ocean abundance and fishery impact estimates (Hindcast Analysis), and 2) development and application of a KRFC population model that incorporated available information on stock productivity, stock dynamics, effect of ocean and river fisheries on stock abundance, and precision of pre-season stock abundance and ocean fishery impact projections (stochastic stock recruitment model; SSRM). A bootstrap analysis of hindcast results was used to project probabilities for meeting certain biological criteria. A statistical analysis was done relating natural spawning escapement in the Salmon, Scott, and Shasta Rivers to total Klamath Basin natural spawning escapement using the SSRM.

Economic impacts of the alternatives were projected for: 1) a Conservation Alert Year (<35,000 natural spawners; CAY) using the Klamath Ocean Harvest Model (KOHM), and; 2) long term using the SSRM to project 40-year average impacts. Ocean fishery regulation scenarios for each alternative were developed for a CAY. The ocean recreational fishery outside of the Klamath Management Zone (Humbug Mountain, Oregon, to Horse Mountain, California; KMZ) assumed full fishing seasons, except for the Status Quo Alternative, which had all fisheries closed except those that had no observed KRFC impacts. The Fishery Economic Assessment Model (FEAM) was used to project economic impacts of the alternatives on local communities and states. Historical troll fishery success rate data were used to project a range of troll fishery impacts for the alternatives. Recent years' ex-vessel price information was used to show the impact of price on the value of troll salmon landings. Supplemental economic data and analyses were included to demonstrate the importance of salmon troll fishing to coastal communities and the states. Information supplied by the Yurok tribe was used to estimate impact of the alternatives on tribal commercial fishing. California river recreational fishery data and survey results were used to estimate economic impact of the alternatives on the river recreational salmon fishery.

The results from the analyses show differences between the Hindcast and SSRM approaches. The Hindcast Analysis was based on pre-season projections, which generally underestimated ocean stock size and fishery impacts. The Hindcast Analysis was also static and did not take into account the effect of reduced stock size on future production. Thus, it was "optimistic" in terms of natural spawner goal attainment. The SSRM provided post-season estimates and was based on the best information available for the fish and fisheries. Measurement error was factored into the calculations, which produced large population and catch levels in some years that tended to mask differences in the alternatives. Also, the SSRM was theoretical, only using actual population abundance data to start the model iterations. The SSRM was calibrated to approximate historical averages of certain fishery and population data, and results likely bracket the range of possible outcomes. While historical data are presented for context purposes, the SSRM could not simultaneously represent all variables accurately, and interpretation of the results are best viewed as relative differences between the Status Quo Alternative and the various fixed cap alternatives (Tables ES-1 and ES-2; Figures ES-2 through ES-6). Generally, there were only modest increases in risk with the fixed cap alternatives relative to the Status Quo Alternative in the SSRM analysis. The most notable exceptions were the probability of a natural spawning escapement less than 12,000 and the probability of a mid-Basin substock natural spawning escapement less than 720 (described below).

A summary of the results for the 40-year simulation period follows:

<u>Biological Criteria</u>

1) Probability of <12,000 natural spawners: SSRM results show very low probabilities for all alternatives, with small absolute differences among alternatives, but more substantial differences between the fixed cap alternatives and the Status Quo Alternative.
2) Probability of any mid-Basin natural escapement falling below 720 adults in any year: SSRM results show less than 5 percentage point difference between the alternatives, which are lower

than historical data. The relative difference compared to the Status Quo Alternative was 5%-12% greater for the 5% Cap Alternative, but 25% to 25% greater for the 13% Cap Alternative.

3) Probability of <35,000 natural spawners: The results were of the Hindcast and SSRM analyses were very similar for the 10% Cap and 13% Cap Alternatives, but the Hindcast Analysis had much lower probabilities for the Status Quo and 5% Cap Alternatives. This may have been due to the use of pre-season data in the Hindcast Analysis. Historical data showed a higher incidence of years with less than 35,000 natural spawners than either projection method.
4) Probability of 3 yrs of <35,000 natural spawners: The SSRM had high probabilities for all alternatives, which increased by 12 percentage points between the Status Quo and 13% Cap Alternatives. The Hindcast Analysis had lower probabilities for all alternatives, but a large difference between the Status Quo/5% Cap Alternatives and the higher impact rate alternatives (10% Cap and 13% Cap). Again, the use of pre-season data in the hindcast data may have influenced the results. Historical data show one overfishing concern (<35,000 natural spawners in 3 consecutive years) in 17 years.
5) Probability of meeting hatchery goals: The SSRM projects very high (>70%) and similar egg take probabilities for all alternatives.

ESA Standards

6) Probability of meeting CCC salmon ESA consultation standard: The SSRM estimated all alternatives would meet the standard in most years, and differences between the alternatives were within 5 percentage points. Historical data showed the standard being met in 50% of years.

Socio-Economic Impacts

7) Ocean recreational fishery impacts were based on a CAY. The estimates showed a large difference between the Status Quo Alternative and all of the fixed cap alternatives. The differences among fixed cap alternatives were relatively small because the only recreational fishery affected by the alternatives was the KMZ fishery.
8) Troll fishery impacts for a CAY showed major differences between each of the alternatives, ranging from zero economic impact under the Status Quo Alternative to over $18 million annually under the 13% Cap Alternative. The long-term analysis showed a 39% greater economic impact of the 13% Cap Alternative compared to the Status Quo Alternative, with intermediate results for the other fixed cap alternatives. The troll fishery economic impact projections were about half of 2001-2005 average annual troll fishery economic impacts to local communities and states.
9) The Tribal fishery allocation in a CAY would not meet the tribal subsistence need of 12,000 adult KRFC under any alternative; the SSRM predicted Tribal fishery catch in a CAY decreased between the Status Quo and 13% Cap Alternatives (Figure ES-5). The long-term projection using the SSRM showed the tribal subsistence need being met in 75% to 76% of years. Historical data showed tribal fishery subsistence needs met in about 60% of years.
10) Tribal commercial fishing would not be expected in a CAY. The long-term projected economic impact was the same for all alternatives at $1.5 million annually in fisherman personal income. Historical data indicated actual Tribal fisherman personal income totaling about $900,000 annually in years when commercial fishing took place.
11) The river recreational fishery economic impact (angler expenditures) in a CAY was estimated to be zero under the Status Quo Alternative with approximately proportional increases in economic impact between the fixed cap alternatives, ranging from $760,000 annually for the 5% Cap Alternative and $1.4 million annually for the 13% Cap Alternative. The long-term projection had very similar economic impacts under all alternatives at about $2.8 million annually.

Table ES-1. Comparison of Alternatives relative to evaluation criteria and Klamath Basin historical data.

Impact Criterion	Method	Alternative: Status Quo	5% Cap	10% Cap	13% Cap	Historical Average
Biological Criteria						
Probability of a natural spawning escapement lower than any historically observed (12,000)	SSRM[a/]	1%	1%	2%	3%	6%
Probability of any of the major mid-Klamath Basin substocks having a natural spawning escapement of less than 720 adults in any year.	SSRM	15%	16%	18%	19%	35%
Probability of a spawning escapement below the 35,000 natural spawner floor in any year.	Hindcast[b/]	9%	13%	31%	31%	47%
	SSRM	27%	28%	30%	32%	47%
Probability of three consecutive years of spawning escapement less than the 35,000 floor within a 40-year time period.	Hindcast	3%	3%	59%	58%	100%
	SSRM	70%	74%	79%	82%	100%
Probability that hatchery egg collection goals will be met every year.	SSRM	70%	70%	70%	69%	NA
ESA Consultation Standard						
CCC salmon (probability of exceeding Klamath fall Chinook Age-4 ocean harvest rate standard of	SSRM	39%	39%	40%	44%	50%
Socio-Economic Criteria						
Ocean recreational fishery local impacts ($ millions)	KOHM/FEAM-CAY[c/d/e/]	$ 1.0	$ 25.6	$ 27.7	$ 28.9	$ 26.4
Troll fishery local and state impacts ($ millions)	KOHM/FEAM-CAY[f/]	$ 0	$ 8.2	$ 13.9	$16.2	NA
	SSRM/FEAM-long-term[f/g/]	$ 13.2	$ 14.8	$ 16.8	$ 18.4	$ 37.6
Tribal fishery subsistence need (proportion of years)[h/]	KOHM-CAY	0%	0%	0%	0%	0%
	SSRM-long term	76%	76%	75%	75%	58%
Tribal fishery economic impact ($ millions)[i/]	KOHM-CAY	$0	$0	$0	$0	$0
	SSRM-long term	$1.5	$1.5	$1.5	$1.5	$0.9
Klamath River recreational fishery economic expenditures ($ millions)	KOHM-CAY	$0.0	$0.0	$0.0	$0.0	NA
	SSRM-long-term	$2.8	$2.8	$2.8	$2.8	NA

a/ SSRM = stochastic stock recruitment model. All probabilities reflect long-term risk (40 year simulation period).
b/ Analysis of 1985-2006 pre-season stock abundance data .
c/ KOHM = Klamath Ocean Harvet Model.
d/ FEAM = Fishery Economic Assesssment Model.
e/ CAY = Conservation Alert Year (<35K natural spawners projected).
f/ Medium success rate scenario used.
g/ Long-term analysis is 40-years.
h/ Minimum tribal subsistence need assumption was 12,000 adult KRFC.
i/ Assumes each fish is worth $45 to tribal fisherman.

Table ES-2. Key short- and long-term results from KRFC SSRM for *de minimis* fishing alternatives as a percentage of the Status Quo Alternative.

	Alternative[a/]			
Key Factors:	Status Quo[b/]	5% Cap[c/]	10% Cap[d/]	13% Cap[e/]
Years Spawning Escapement < 35,000[f/]	0.271	105%	113%	118%
Years 1-5	0.461	105%	112%	116%
Years 6-40	0.244	105%	113%	119%
Years Spawning Escapement <12,000[g/]	0.011	132%	195%	293%
Years 1-5	0.019	121%	153%	337%
Years 6-40	0.009	135%	208%	280%
Years Tributary Spawning Escapement <720[h/]	0.149	107%	118%	129%
Years 1-5	0.221	112%	132%	149%
Years 6-40	0.139	105%	115%	159%
Years Egg Take ≥ Goali/	0.705	100%	99%	98%
Years Age-4 Ocean Harvest Rate ≥ 0.16[i/]	0.389	100%	103%	112%
Years 1-5	0.264	98%	108%	135%
Years 6-40	0.407	100%	102%	110%
Years Alternative Implemented[j/]	0.147	101%	135%	161%
Frequency of Overfishing Concerns in 40 Years[k/]	2.19	108%	120%	131%
Average Annual Ocean Harvest; Troll and Sport Fisheries Combined	32,832	101%	101%	102%
Years 1-5	21,086	103%	106%	108%
Years 6-40	34,510	101%	101%	101%
Average Annual Tribal Harvest	48,834	100%	99%	99%
Years 1-5	33,010	101%	101%	101%
Years 6-40	51,095	100%	99%	99%
Average Annual River Recreational Harvest	12,071	100%	100%	100%
Years 1-5	8,331	101%	100%	100%
Years 6-40	12,605	100%	100%	100%
Average Annual Natural Spawning Escapement	72,444	99%	96%	94%
Years 1-5	58,002	96%	91%	87%
Years 6-40	74,507	99%	97%	95%

a/ All Alternatives include the CCC ESA consultation standard limitation of ≤16.0% age-4 ocean harvest rate (landed catch only; ≈17% age-4 ocean impact rate).

b/ No fishing when projected natural spawning escapement <35,000.

c/ *De minimis* fishing limited to no more than a 5% age-4 ocean impact rate with a threshold of unfished natural spawning escapement of less than about 40,000.

d/ *De minimis* fishing limited to no more than a 10% age-4 ocean impact rate with a threshold of unfished natural spawning escapement of less than about 47,000.

e/ *De minimis* fishing limited to no more than a 13% age-4 ocean impact rate with a threshold of unfished natural spawning escapement of less than about 52,000.

f/ Probability of an escapement less than the 35,000 natural spawner floor (KRFC conservation objective) in any one

g/ Probability of an escapement less than 12,000 natural spawners (lowest on record) in any one year.

h/ Probability of a major mid-Klamath tributary (Shasta, Scott, or Salmon rivers) escapement less than 720 natural spawners (genetic/long-term productivity risk) in any one year.

i/ Probability of not meeting the ESA consultation standard for California Coastal Chinook ESU age-4 coean harvest rate ≤ 16.0%) in any one year.

j/ Probability that a *de minimis* fishery alternative, or no fishing in the case of the Status Quo Alternative, will be implemented (no fishing spawning escapement is less than the threshold) in any one year.

k/ Number of independent Overfishing Concerns triggered during the 40 year simulation period.

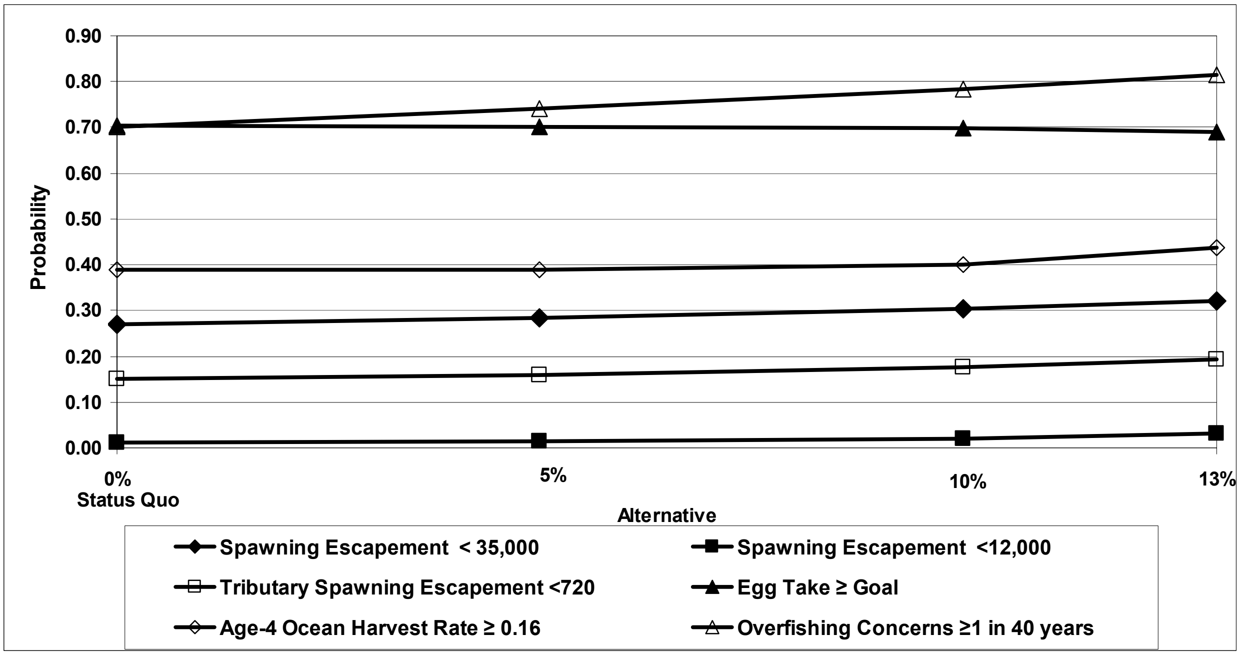

Figure ES-2. Probability of key population events under *de minimis* fishing alternatives based on 40 year SSRM simulations.

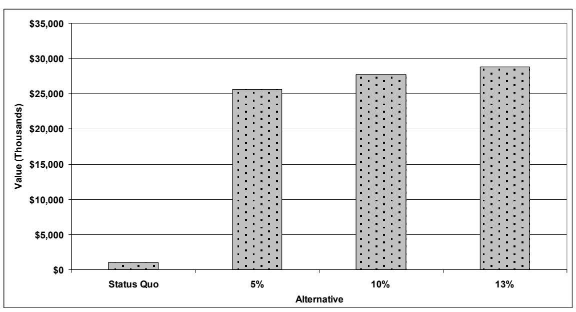

Figure ES-3. Ocean recreational salmon fishery economic impacts for a Conservation Alert Year.

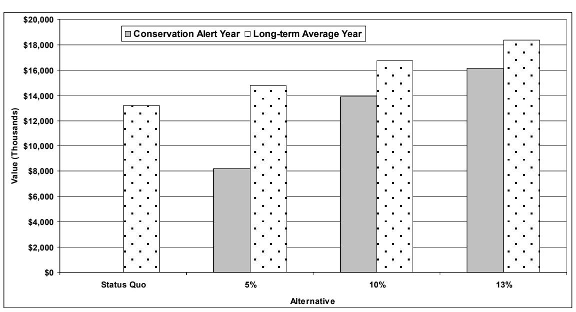

Figure ES-4. Troll fishery economic impacts for a Conservation Alert Year and the annual long-term average.

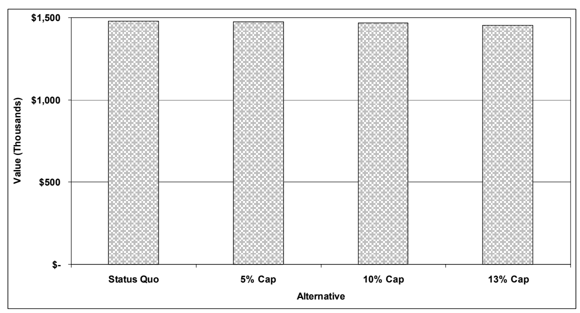

Figure ES-5. Long-term annual average economic impact of tribal commercial fishery.

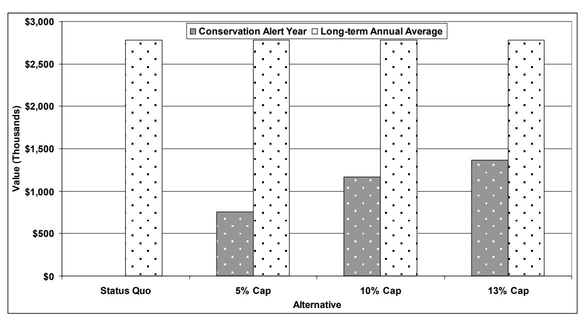

Figure ES-6. Economic impacts of alternatives on Klamath River recreational fishery in a Conservation Alert Year and the long-term annual average.

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1.0 INTRODUCTION

This Salmon Fishery Management Plan (Salmon FMP) amendment process began in November 2005 for the purpose of initiating scoping of an FMP amendment to consider *de minimis*[1] during years of low ocean abundance of Klamath River fall run Chinook salmon (KRFC). The initial interest in the amendment was the result of constraints on the 2005 fishery due to the depressed status of KRFC, which reduced access to a record forecast abundance of California Central Valley fall run Chinook salmon. The Council's direction came after the Scientific and Statistical Committee's (SSC) review of the Salmon Technical Team's (STT) analysis of stock recruitment relationships for naturally spawning KRFC (STT 2005) and a recommendation from the Klamath Fishery Management Council (KFMC) to initiate a Salmon FMP amendment process (PFMC 2005). The need for a *de minimis* fishing amendment for KRFC was elevated during the 2006 ocean salmon fishery regulation process when it was projected that the conservation objective for KRFC of 35,000 naturally spawning adult fish would not be met absent fishing prior to September 1, 2006. This meant that all ocean salmon fisheries having an impact on the stock would not be allowed to open except by emergency rule implemented by the National Marine Fisheries Service (NMFS). The NMFS review resulted in an emergency rule which allowed for a small amount of fishing below the stock conservation objective as specified in Table 3-1 of the Salmon FMP. Analyses were provided in Section 4 that demonstrated the effects of policy alternatives related to various *de minimis* fishing alternatives on the long-term viability of KRFC and the economic impacts of those policy alternatives on fishing communities.

Any material summarized and incorporated into this Environmental Assessment (EA) by reference may be obtained by contacting the Council at the address on the front of this document. In-text citations are not always given for Council-produced documents referred to in this EA. Copies of these documents may be obtained from the Council office or website (http://www.pcouncil.org/).

1.1 Document Organization

This is an integrated document in regard to the assessments required for an FMP amendment. The Council decision process for this initiative is outlined in Section 1.3. The description of the proposed amendment and impacts in Sections 2.0, 4.0 and 5.0 contain key elements necessary for a Regulatory Impact Review/Initial Regulatory Flexibility Analysis (RIR/IRFA) and draft EA. Section 5.0 summarizes the relationship of this amendment to other existing laws and policies. Section 5.5 contains or references the information required for a structurally complete RIR/IRFA. The proposed FMP wording relating to Council action required when a Conservation Alert is triggered for KRFC appears in Section 6.0. Appendix A contains the names and affiliations of the Salmon Amendment Committee (SAC) and Sub-committee members. Appendix B contains a description of the Klamath River Basin salmonid escapement monitoring programs. Appendix C provides historical information on the contribution of hatchery and natural origin KRFC to ocean fisheries. Appendices D and E provide a statistical description of the formulas used in the Hindcast Analysis presented in Section 4.2.1. Appendix F includes pre- and post-season population and fishery data. Appendix G describes the population model used to analyze the Council's *de minimis* fishery alternatives. Appendix H describes the analysis of sub-stock effective population size. Appendices I and J provide information used in the economic analyses, and Appendix K includes Lower Klamath River recreational salmon fishery creel census data.

1.2 Purpose and Need for Action

This action is to amend Salmon FMP (PFMC 1997) to allow minimal or *de minimis* fisheries in years when the KRFC conservation objective is projected not to be met. Alternatives are presented for

[1] *De minimis* is Latin for "of minimum importance" or "trifling." Essentially it refers to something or a difference that is so little, small, minuscule, or tiny that effects need not be considered.

determining a minimum harvest rate for age-4 fish that would be allowed under de minimis fisheries. The Salmon FMP directs ocean salmon fishery management actions relative to the exclusive economic zone (EEZ) off the coasts of Washington, Oregon, and California. Under the existing Salmon FMP, a pre-season projection that the conservation objective for KRFC will not be met triggers a Conservation Alert, which provides the Council and NMFS only one option: to close all salmon fisheries within its jurisdiction that impact the stock. .These fisheries include ocean salmon fisheries between Cape Falcon, Oregon and Point Sur, California. Currently, any other option can only be addressed through the emergency regulation process as provided in the Magnuson-Steven Fishery Conservation and Management Act (MSA) and implemented by NMFS.

The purpose of this action is two-fold: first, to give more flexibility to the rule-making process when the conservation objective for KFRC is projected not to be met; and second to provide for appropriate opportunities to access more robust Chinook salmon stocks that are typically available in the Council management area. At a minimum, this should allow for Council action without the need for NMFS to declare and approve an emergency rule while providing for minimal or *de minimis* salmon fishery impacts on KRFC.

This action is needed to prevent fishery restrictions that impose severe economic consequences to local communities and states. Historically, KRFC was a primary contributor to marine fisheries off the coasts of Oregon and California. While this amendment seeks to provide management flexibility in times of scarcity, there is an overriding purpose to preserve the long-term productive capacity of the stock to ensure meaningful contributions to ocean and river fisheries in the future.

In 2006, the status of KRFC included a failure to meet the 35,000 natural adult spawner escapement floor for the stock for the past two years, and a projected natural spawner escapement of 21,100 under the adopted 2006 ocean fishing regulations. Council area fisheries in September and October 2005 harvested approximately 6,100 KRFC, and assuming freshwater tribal fisheries harvested their entitled equal number of KRFC, the natural spawning escapement projection for 2006 absent fishing was 25,400 fish. However, after reviewing the available data on the stock during its March and April meetings, and in collaboration with NMFS, the states, tribes, and ocean fishermen, the Council determined that conditions in 2006 met the criteria to temporarily amend the Salmon FMP KRFC conservation objective to allow a limited fishery that would reduce the projected natural escapement to 21,100 natural adult spawners. This increase in impacts to KRFC was determined to be acceptable in terms of maintaining the long-term productivity of the stock while balancing the economic needs of the fishing community and states. NMFS concurred with the Council assessment and implemented emergency regulations effective May 1, 2006 (www.pcouncil.org/newsreleases/noaa_pr_04-28-2006.pdf). If post-season data indicate the stock did not meet its minimum conservation objective in 2006, it will be the third consecutive year. This would trigger an Overfishing Concern, which would likely result in a declaration by NMFS of the stock being overfished and initiation by the Council of a stock rebuilding plan.

1.3 Plan Development Schedule and Council Advisory Committee Participation

The expectation for this FMP was that the Council would recommend to the Secretary of Commerce (Secretary) adoption of an amended Salmon FMP in time for implementation of regulations affecting ocean salmon fisheries commencing May 1, 2007. However, the exact form and wording of the final recommendations depended on the results of the analyses and findings that are presented in this document. To facilitate this effort an *ad hoc* Salmon Amendment Committee (SAC) was appointed to analyze *de minimis* fishing alternatives and to report to the Council on the progress of the overall initiative[2].

The committee structure included two subcommittees with specific duties, with the balance of the committee in essentially an advisory role with regard to reviewing and making recommendations on technical approaches or policy considerations, reviewing subcommittee reports, and providing general quality control inputs. One subcommittee was responsible for preparing the draft amendment and Council or public review documents, including modeling and analytical components and written narratives (Document Subcommittee). The other subcommittee was charged with Federal regulatory streamlining responsibilities, including the Council: NMFS interface and Federal internal policies to allow for timely Secretarial review and an approval/disapproval decision of the final Council action at the November 2006 meeting (Regulatory Streamlining Subcommittee). Individual SAC members were called upon to prepare or submit report sections depending on their particular area of expertise and availability to assist in Council activities. The names of committee members and their affiliations appear in Appendix A.

1.3.1 Council Decision Process

The Council recommendations for *de minimis* fishing impacts for KRFC were based on findings using a stepwise process, as follows:

1. Thorough review of the history, management framework, scientific literature, pertinent regulatory documents and administrative orders, and social and economic data as they relate to the management of KRFC and co-mingled stocks;
2. Development of a set of *de minimis* fishing alternatives using the Council meeting process to solicit input from the public and Council advisory groups;
3. Analysis and evaluation of *de minimis* fishing alternatives relative to i) NOAA Environmental Review Procedures, ii) the National Standards of the MSA, iii) the long-term productivity of the stock, iv) protection of ESA species, v) community economic impacts, and vi) other applicable law; and
4. Establishment of the biological conditions, regulatory timeframe, and associated regulatory considerations for implementation of *de minimis* fishing regulations for KRFC as part of the Council's annual ocean salmon management process.

1.4 Background and Related Documents

1.4.1 History of KRFC Management

KRFC have been under Council management since 1978. The initial conservation goal for the stock was an annual spawning escapement of 115,000 adult fish, which included 97,500 naturally spawning fish and 17,500 hatchery fish (CDFG 1982). There were regular shortfalls in meeting the spawner goal in early years, stemming from low stock size in combination with heavy ocean and river fishing impacts. The lower river tribal fisheries began to take a significant quantity of fish stemming from the resumption of river gill-net fishing in 1977. The history of tribal fishing on the Klamath and Trinity rivers is reported by Pierce (1998).

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[2] The cause of the current depression in abundance of KRFC and its effect on ocean and river fisheries was a concern to everyone involved in the development of this initiative. It is likely that a stock status review will be required for KRFC after data for the 2006 spawning escapement have been finalized, and it will be in that forum, or others that are currently under way or being considered, that issues of low juvenile survival and stock productivity will be reviewed, analyzed, and, hopefully, addressed. Some contributors to this document felt our time would be better spent working on the cause of the survival/productivity problem for KRFC. However, high priority was given by the SAC overall to this initiative to avoid a repeat of the 2006 ocean salmon emergency regulatory process that was a disappointment to fishermen and managers alike.

The first conservation goal change for KRFC was in 1983 when emergency action was taken to adopt a stock rebuilding plan. It called for an average 20% increase in ocean escapement (river run size) per four-year period beginning in 1983-1986, leading up to an average river run size of 115,000 adult fish, which then became a spawning escapement goal (PFMC 1983).

Very low natural spawning escapements of KRFC occurred in 1983 and 1984. The situation led to closure of the troll fishery and a partial closure of the recreational fishery between Point Delgada in northern California and Cape Blanco in southern Oregon in 1985. The 1985 ocean fishery closures led to the formation of the *ad hoc* Klamath River Salmon Management Group (KRSMG). The KRSMG first met in May of that year with the aim of reaching agreement on 1) a conservation goal for the stock based on spawning fish and 2) allocation of harvest. The KRSMG formed a technical team, the Klamath River Technical Team (KRTT), which was charged with developing and evaluating conservation and harvest sharing alternatives for KRFC (OSP 1985).

A "harvest rate plan" for KRFC was developed by the KRTT and approved by the KRSMG in 1986. The plan called for a 35% escapement rate (later changed to 33-34%) for each brood of fish except that 35,000 naturally spawning adults would be protected in all years (35,000 escapement floor, KRTT 1986). The KRTT report is the original source for the 35,000 fish escapement floor, which remains a key feature of the conservation objective for KRFC in the current salmon FMP. The KRTT concluded that the escapement floor of 35,000 was needed to protect the production potential of the resource in the event of several consecutive years of adverse environmental conditions. At the time the KRTT concluded that the escapement floor represented approximately 50% of the adults required to achieve the best available estimate of maximum sustained yield (MSY).

The KRTT report also provided the basis for a 5-year harvest sharing agreement that allowed for ocean and river harvest rates for age-4 fish of 0.35 and 0.50, respectively (PFMC 1986 note - not in references). The five-year harvest sharing agreement of the KRSMG/KFMC that was signed in 1986 ended in 1991, but was replaced by a new agreement reached by the KFMC. The agreement was adopted based on Hubbell and Boydstun (1985); KRTT (1986); PFMC (1988); with minor technical modifications in 1989 and 1996.

The harvest rate plan recommended by the KRTT was subsequently adopted as part of Salmon Plan Amendment 9 (PFMC 1988), which was first implemented in ocean fishing regulations beginning May 1, 1989. The Plan Amendment incorporated use of the 35,000 fish escapement floor as part of the management objective for KRFC. The Council concluded that inclusion of the floor protected the stock by reducing the risk of prolonged depressed production, provided greater long term yield, and resulted in a high probability of attaining sufficient escapement for hatchery production.

Low projected stock size in 1992 led to emergency regulatory action affecting ocean fisheries to allow for a natural spawning escapement of 27,000 adult fish. The adopted regulations were based on an 8% age-4 ocean harvest rate on KRFC (PFMC 1992).

In 1993, the Interior Department Solicitor issued a legal opinion that concluded the Yurok and Hoopa Valley Tribes of the Klamath Basin had a Federally protected right to 50% of the available harvest of Klamath Basin salmon. The tribes were allocated 50% of the annual allowable catch of KRFC beginning in 1994 (Pierce 1998).

Failure to meet the 35,000 natural adult escapement goal in 1990-1992 led to an overfishing review by the KFMC and Council (PFMC 1994). A more conservative approach to projecting ocean abundance of the stock was adopted (ocean abundance regressions were run through zero).

As part of its ongoing commitment to for periodic review of management objectives, the Council asked the KFMC to conduct a modeling study of stock, recruitment, and yield of KRFC. The objective of the study was to evaluate the present management policy, and, particularly, the 35,000 fish escapement floor. The task was assigned to the Klamath River Technical Advisory Team (KRTAT). The KRTAT updated data and analysis done originally by the KRTT (1986), and explored new areas including the effects of environmental variability on recruitment. The KRTAT (1999) concluded that use of the 35,000 fish escapement floor remained a prudent choice and "near optimal" for the purpose of optimizing yield.

Ocean fishery management to protect ESA listed California Coastal Chinook (CCC) salmon began in 2000. The NMFS ESA consultation standard resulted in a limitation on ocean fishery impacts on age-4 KRFC to ≤ 17% (lowered to ≤ 16% in 2002). This rate was below the long-term ocean harvest rate for KRFC and was used to curb further declines in abundance of CCC salmon stemming from ocean fishery impacts. The consultation standard takes precedence over the Council's 67% spawner reduction policy (harvest rate policy) as it applies to ocean fisheries, but does not affect Klamath Basin river fisheries.

In 2005, the Council asked for a review of the technical basis of the 35,000 escapement floor, (STT 2005a) and for a review of the relationship between spawning escapement and recruitment for KRFC (STT 2005b). The STT updated the information, explored several alternative spawner-recruit models, and also considered the effects of environmental factors on recruitment. The STT did not comment specifically on the 35,000 fish escapement floor, but did provide a range of MSY escapement values that depend on the assumptions and models used. Model 2 from the STT report provided an estimate of MSY escapement of 40,700 which is used as the best available estimate. Although the current estimate of MSY escapement is somewhat lower than the estimate provided by the KRTT (1986) twenty years ago, the Council remained committed to reliance on the escapement floor as part of the management objective for KRFC. When the escapement floor was adopted into the Salmon FMP through Amendment 9, the Council required that modification of the floor could only occur by Plan amendment. The Council initiated Amendment 15 for the purpose of exploring the use of *de minimis* fishing levels when projected escapement was below the floor, but specifically declined to consider modifying the floor itself; thus, indicating their continued commitment to the 35,000 fish floor as a conservation objective.

A very large abundance of Sacramento River fall-run Chinook salmon was projected for the 2005 ocean fishing season, but fisheries had to be restricted because of depressed status of KRFC. This led to Council discussion about a provision in the Salmon FMP for *de minimis* fishery impacts on KRFC in order to access more robust ocean salmon stocks. In2006, critically low abundance of KRFC led to emergency action to allow for a low level of ocean fishing. Formal public scoping for Salmon FMP Amendment 15 to allow for *de minimis* fishery impacts on KRFC began in March 2006.

1.4.2 Management Framework

Fishery Descriptions

Chinook salmon (*Oncorhynchus tshawytscha*) and coho salmon (*O. kisutch*) are the primary species of Pacific salmon harvested in ocean fisheries off Oregon while Chinook salmon is the primary species harvested off California. There are 43 stocks of Chinook salmon, and 20 coho salmon stocks, that are managed under the Salmon FMP. Salmon stocks co-mingle in the ocean to varying degrees, depending on their life history characteristics and ocean distributions. ESA constraints limit coho fishing off Oregon to hatchery-marked fish while coho retention is prohibited in all California ocean fisheries. Coho fishing for marked hatchery fish off Oregon south of Cape Falcon has been limited to recreational angling.

Salmon are legally taken off Oregon and California only by hook-and-line. Fishing is usually by trolling from a boat. Mooch or drift fishing is the other common fishing method, and is more prevalent in some areas than in others. Most fish are taken in open ocean waters, but some are taken in the mouths of harbors or rivers or in bays or estuaries. Commercial salmon trollers use multiple leaders with attached lures or baits. Commercial trollers are limited in regulation by the number of main troll lines they may use. Recreational anglers are limited to one rod and line per angler north of Point Conception, California. Charter boats carry salmon anglers for hire at the major ports while private boats operate from the smallest to the largest ports.

KRFC are taken in river in tribal and non-tribal salmon fisheries using traditional fishing methods. The tribal fisheries with recognized Federal fishing rights occur on the Yurok and Hoopa Valley Indian reservations located on the Lower Klamath and Trinity Rivers, respectively. These fisheries primarily use gill nets to harvest KRFC. Net mesh size, overall net length and other allowable fishing methods are regulated by tribal ordinances. Non-tribal river recreational salmon fishing takes place throughout the Klamath Basin. River anglers are limited to using a single rod, line and hook. Guide services are available at a few locations on the main stem Klamath and Trinity rivers.

Fishery Allocations

With the exception of a 50% allocation to the Klamath tribes, allocation decisions are based on annual negotiations and preseason Council recommendations. As described in other parts of this EA, the pre-season ocean and river fishery allocations of KRFC in recent years were as follows. The Tribal river fishery shares the total allowable catch of KRFC with non-tribal ocean and river fisheries on a 50/50 basis based on age-3 to age-5 fish. The non-tribal catch has typically been allocated: 15% (7.5% of total) to the river sport fishery and 85% to the combined ocean troll and recreational fisheries. Within the ocean fishery allocation, the Klamath Management Zone (Humbug Mountain, Oregon to Horse Mountain, California; KMZ) recreational fishery has typically been allocated up to 17% of the ocean KRFC catch. The Oregon and California troll fisheries have shared the remaining KRFC catch using 50/50 sharing for the development of at least one ocean fishery alternative at the March meeting. The final troll fishery sharing can vary depending on abundance of co-mingled stocks and protective measures for ESA salmon species.

The tribal fisheries normally set aside a small (unquantified) number of fish for ceremonial purpose. Tribal subsistence needs are the next highest priority use of KRFC by the Tribes. The subsistence catch has been as high as 32,000 fish since 1987 when separate tribal use accounting was implemented. Generally, commercial fishing has been allowed when the total allowable catch was over 11,000 -16,000 adult fall run fish (see:
http://www.pcouncil.org/salmon/salbluebook/App_B_Hist_Esc_FW_Catch_Spawn.xls).

The river sport fishery quota has typically been allocated based on sub-area quotas as follows: 1) the river mouth area closes when 15% of overall quota is taken below 101 Bridge; 2) Klamath River between the river mouth and Coon Creek Falls (river mile 35) closes when 50% of overall quota is reached; and 3) Klamath and Trinity rivers above Coon Creek Falls close when 100 % of the quota is reached (for the most recent Klamath River regulations see: http://www.dfg.ca.gov/mrd/oceanfish2006supplement.pdf).

Fishery Regulation

The annual salmon meetings of the PFMC and KFMC have provided the main forums for conducting and sharing of annual salmon stock status assessments, developing annual fishery management alternatives, and adopting annual and long term management plans for all Council-managed salmon stocks, including KRFC and ESA-listed salmon populations. Participation is open to the public and the other management entities, which have used the PFMC process as the foundation for their own regulatory processes. Each responsible management entity has its own administrative procedures to follow in adopting regulations or ordinances affecting their respective fisheries and areas of responsibility. The Secretary of Commerce establishes annual commercial and sport ocean salmon fishing regulations for the federal Exclusive Economic Zone (EEZ, 3-200 nautical miles offshore) based on recommendations of the PFMC. The Oregon Fish and Wildlife Commission adopts regulations annually for the Oregon ocean recreational and commercial salmon fisheries in state waters. The California Fish and Game Commission set recreational fishing regulations in state waters. The California Department of Fish and Game (CDFG) Director is authorized to conform commercial salmon fishing regulations in state waters to the management plans of the PFMC. The Yurok and Hoopa Valley tribal authorities adopt annual tribal fishing regulations for their reservations, located on the Lower Klamath and Trinity rivers, respectively. The full set of ocean and river fishing regulations are codified in the ordinances or regulatory titles of the responsible management entities. These are made available to the public usually in the form of printed documents or on internet web sites.

Salmon fishing regulations in the EEZ are enforced by the U.S. Coast Guard while regulations in state waters are enforced by the state agencies and NMFS Office of Law Enforcement. River sport fishing regulations are enforced by the CDFG while the tribal regulations are enforced by the respective tribal entities.

Management of ESA-listed Salmon

ESA-listed species are managed under ESA regulations the MFCMA. "Take" (a term that covers a broader range of impacts than just mortality) of listed species may be allowed as long as it is not the primary purpose of the activity. (Therefore, catches of ESA-listed stocks are termed incidental take.) For salmon fisheries, this means incidental mortality may be allowed (including, for example, fish that are released or "drop off" the hook and consequently die). As part of the process authorizing such take, regulatory agencies must consult with NMFS[3] in order to ensure fisheries conducted in the Council area do not "jeopardize the continued existence of the species" (or in the case of salmon, the listed ESUs). Because of the Council's central role in developing fishery management regimes, it must take the results of such consultations into account. Typically this process, termed a "Section 7 consultation" after the relevant section in the ESA, results in a BO that applies a set of consultation standards to the subject activity and mandates those actions that must be taken in order to avoid such jeopardy. As listings have occurred, NMFS has initiated formal Section 7 consultations and issued biological opinions (BOs) that consider the impacts to listed salmonid species resulting from proposed implementation of the FMP (long-term opinions), or in some cases, from proposed implementation of the annual management measures. The consultation standards, which are quantitative targets that must be met to avoid jeopardy, are also incorporated into the Salmon FMP and play an important part in developing annual management measures. A Section 7 consultation may be reinitiated periodically as environmental conditions change, and new measures may be required to avoid jeopardy. (BOs s for Council-managed salmon stocks are listed in Section 5.3.2 and are available from the NMFS Northwest Region office. These documents also provide detailed information on the biology and status of these stocks.)

In addition to the Section 7 consultation, actions that fall under the jurisdiction of the ESA may also be permitted through ESA Section 10 and ESA Section 4(d). Section 10 generally covers scientific, research, and propagation activities that may affect ESA-listed species. Section 4(d) covers the activities of state and local governments and private citizens.

Section 4(d) of the ESA requires NMFS and the U.S. Fish and Wildlife Service to promulgate "protective regulations" for threatened species (Section 4(d) is not applicable to species listed as endangered) whenever it is deemed "necessary and advisable to provide for the conservation of such species."

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3 NMFS is the designated agency for listed West Coast anadromous and marine species. The U.S. Fish and Wildlife Service is responsible for listed terrestrial species.

> "Whenever any species is listed as a threatened species pursuant to subsection (c) of this section, the Secretary shall issue such regulations as he deems necessary and advisable to provide for the conservation of such species. The Secretary may by regulation prohibit with respect to any threatened species any act prohibited under section 9(a)(1) of this title ..."

These protective rules for threatened species may apply to any or all of the ESA Section 9 protections that automatically prohibit take of species listed as endangered. The rules need not prohibit all take. There may be an "exception" from the prohibitions on take, so long as the take occurs as the result of a program that adequately protects the listed species and its habitat. In other words, the 4(d) rule can restrict the situations to which the take prohibitions apply.

Sec 9(a)(1) includes the take prohibition. The U.S. Fish and Wildlife Service adopted a blanket regulation automatically applying the take prohibition to all threatened species upon listing. NMFS has no comparable blanket 4(d) regulation. Instead, NMFS promulgates 4(d) regulations on a species-by-species basis once a species is listed as threatened.

In proposing and finalizing a 4(d) rule, NMFS may establish exemptions to the take prohibition for specified categories of activities that NMFS finds contribute to conserving listed salmonids. Other exemptions cover habitat-degrading activities (and tribal and recreational fishing activities) that NMFS believes are governed by a program that adequately limits impacts on listed salmonids.

As part of the process for developing annual management measures, NMFS summarizes the current consultation standards and may provide additional guidance to the Council on minimizing the take of listed species. Appendix A in *Preseason Report III* summarizes this guidance.

Resource Monitoring

The KRTAT has served to coordinate the monitoring of KRFC and to produce annual stock status and fishery catch and impact estimates. The members represent the various groups and entities involved in the harvest and management of KRFC (see http://www.fws.gov/yreka/tat.htm for more information on the KRTAT). The KRTAT makes annual stock abundance and cohort reconstruction estimates available to the Salmon Technical Team (STT) of the PFMC by mid-February each year.

A representative number of Klamath River hatchery fall Chinook salmon have been marked using coded wire tags (CWTs) and adipose fin clips each year starting with the 1978 brood. Recoveries of these CWT groups have been used to measure fishery impacts on the stock and to reconstruct the life histories of individual broods. River fishery and escapement monitoring have been used to estimate the relative contributions of marked hatchery, unmarked hatchery and naturally produced fish to the total basin production of KRFC. Hatchery CWT contributions have been assumed to be representative of unmarked hatchery fish contributions.

The states of Oregon and California monitor and estimate ocean salmon landings in their respective states. Market receipts in combination with fishery sampling are used to estimate commercial (troll) landings while probabilistic time and area sampling is used to estimate private boat catches as well as charter boat catches in Oregon. Logbook returns in combination with dockside sampling are used to estimate charter boat catches in California. Ocean salmon landing estimates are generated for each state by catch area and month of the season. The sampling rate for collecting CWTs from adipose fin-clipped salmon has generally been around 20% of the landed catch by fishery, area, and month of the season. CWT recovery information and associated expansion factors are generated by the two states and uploaded to the coast wide CWT database maintained by the Pacific States Marine Fisheries Commission.

The CDFG and the Klamath River tribes monitor their respective river salmon fisheries and recommend fishery closures when quotas are projected to be met. Data are collected on fishing effort, catch, and CWT contributions to river fisheries. Spawning escapement monitoring is a joint effort of the CDFG, U.S. Fish and Wildlife Service, U.S. Forest Service, Hoopa Valley and Yurok tribes, and public volunteers. A variety of methods are used to measure the escapements of anadromous salmonids in the Klamath Basin. The river monitoring programs are summarized in Appendix B.

Annual estimates of fishery catches, spawner escapements, spawner age composition and CWT contributions are usually available by early to mid-January each year for use by the STT and the KRTAT in updating KRFC fishery resource estimates, models, and forecasts.

Annual Stock Abundance Projections and Ocean Fishery Contribution Estimates

CWT recoveries in ocean fisheries since the 1977 brood of Klamath Basin hatchery fall Chinook salmon have shown that KRFC are harvested primarily in fisheries off the Oregon and California coasts. Of 101,703 expanded CWTs, 739 (0.7%) were recovered in fisheries north of Oregon (Table 1-1).

Table 1-1. Ocean returns of KRFC hatchery coded wire tags (CWT) by recovery agency since the 1977 brood.

Agency	Raw Tag Recoveries	Expanded Tag Recoveries
Alaska Dept. Fish and Game	0	0
Canadian Dept. Fish. & Oceans	51	242
Washington Dept. Fish & Wildlife[a/]	173	497
Oregon Dept. Fish & Wildlife	14,007	43,459
California Dept. Fish & Game	12,256	57,505
Total	26,487	101,703

a/ Includes 2 raw tag recoveries, or 3 expanded recoveries from the Quinault Indian Nation.

Cohort reconstructions and river monitoring programs are used to project age-specific annual ocean abundance estimates of KRFC, based on the relationship of ocean population sizes and age-specific river run size estimates for the previous spawning season. These projections are used to evaluate ocean fishing regulations aimed at meeting river fishery harvest and stock conservation objectives. The most recent forecast models for 2006 are available at: http://www.pcouncil.org/salmon/salpreI06/chpII.pdf.

The ocean abundance of KRFC has been episodic, with no apparent regularity between stock highs and lows (Figure 1-1; data from PFMC Pre-season Report I, 2006). The low abundance levels of 1990-1992 led to a formal stock status review because of failure to meet the natural escapement floor goal in three consecutive years (PFMC 1994). Another review may be necessary if the stock fails to meet its 35,000 natural escapement floor in 2006 because of escapement goal shortfalls in 2004 and 2005.

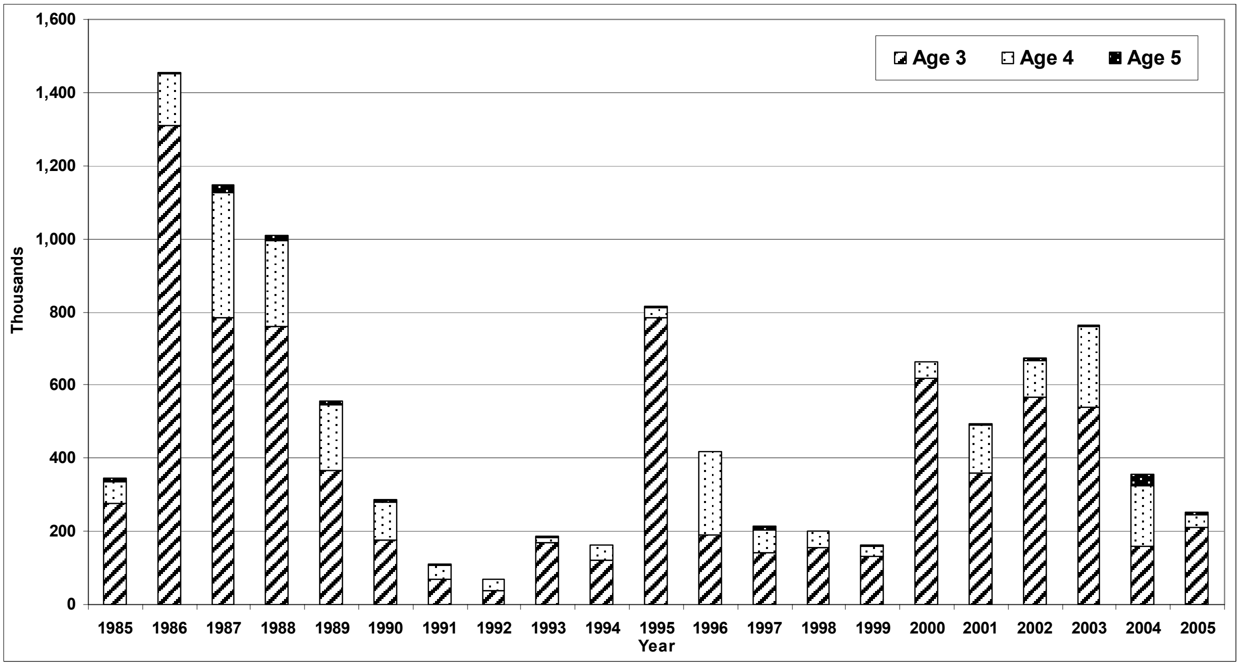

Figure 1-1. Ocean abundance estimates of age-3 to age-5 KRFC, 1985-2005.

Ocean fishery contribution estimates of hatchery and naturally produced fish were displayed in Appendix C. The table indicated most of the fish were age-3 when they were harvested and that naturally spawned fish made up 72% of the total catch during 1983-2005. The data in Appendix C were used to estimate the contribution of KRFC to Oregon and California ocean fisheries during 1983-2005. The data showed that KRFC contributed from 9% to 32% and averaged 17% of the Oregon and California ocean salmon catch during 1983-1990. Beginning in 1991 the annual contribution proportion dropped off to between 1% - 11% and averaged 4% for the remainder of the period. The data showed that ocean fishery management has reduced ocean catches of KRFC over time stemming from reductions in ocean fishing opportunity in areas of highest abundance of the stock. Thus, the data were not indicative of the relative ocean abundance of KRFC compared to other Chinook salmon stocks found off the Oregon and California coasts (Figure 1-2).

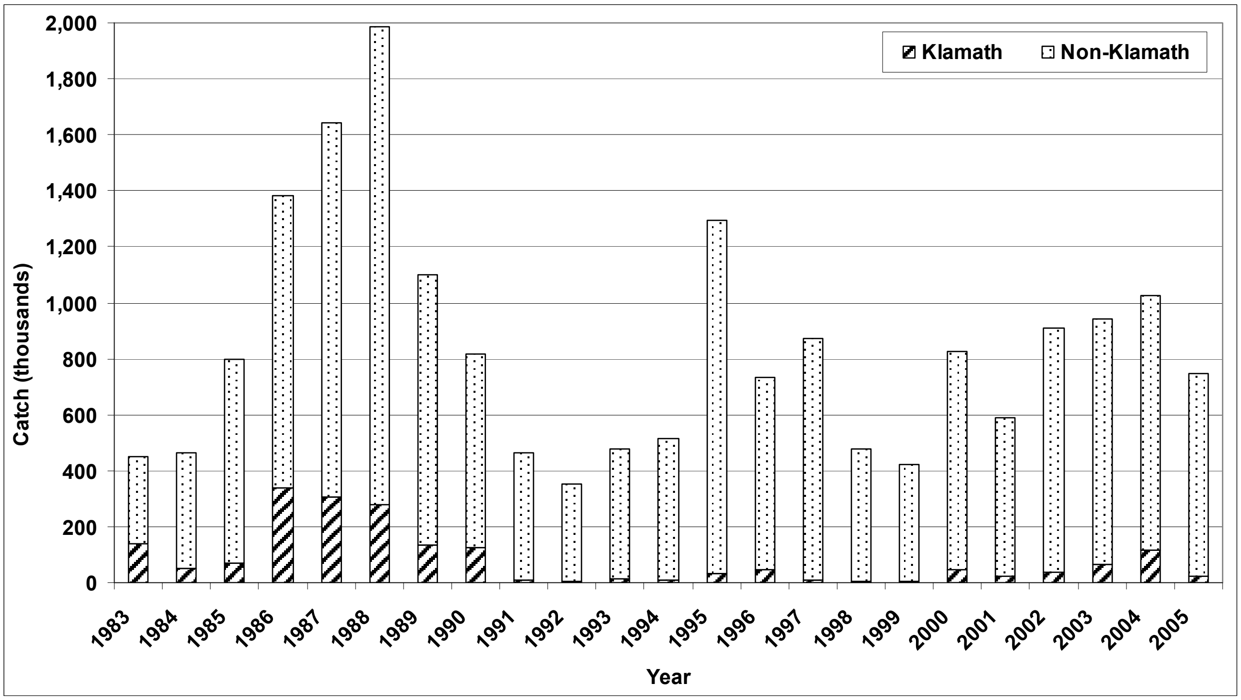

Figure 1-2. Contribution of KRFC to Oregon and California ocean catches, 1983-2005.

Klamath Ocean Harvest Model

An important tool for the management of KRFC is the Klamath Ocean Harvest Model (KOHM) (Goldwasser et al. 2001; Prager and Mohr 2001). The KOHM is used by the KRTAT and the STT to forecast: (1) natural area spawners in the absence of fishing and under proposed regulations, (2) ocean time-area-specific fishery impacts and harvest, and (3) Klamath River tribal and sport fishery impacts and harvests. The forecasts derive largely from the analysis of historical cohorts of hatchery and natural fish based on CWT release and recovery information. The KOHM incorporates stock abundance indices for Central Valley Chinook salmon and Oregon coastal Chinook salmon and, together with KRFC forecasts, result in ocean catch estimates for all three stock units ("all stocks"). Major updates to the KOHM occurred in 2001 and 2006.

The KOHM was modified for analyzing 2006 ocean fishery regulations due to underestimates of ocean fishery impacts on age-4 KRFC in 2003-2005. The model changes included accounting for effort transfers in the Coos Bay and Northern Oregon troll fishery cells and basing the contact rate per unit of effort in the Fort Bragg, San Francisco, and Monterey troll fishery cells on the most recent three years of data. A complete description of the 2006 model changes is available at:
http://www.pcouncil.org/salmon/salpreII06/apdxa.pdf.

1.4.3 Related Documents

There are numerous documents available related to KRFC management, which have been used in the analyses in this EA and support the decision at hand. These documents are briefly described below and their relevance to the analysis is explained.

Pacific Coast Salmon Plan (Salmon FMP)

The Salmon FMP establishes conservation and allocation guidelines for annual management. This framework allows the Council to develop measures responsive to conditions in a given year. Section 3 of the Salmon FMP describes the conservation objectives for Salmon Fishery Management Unit (Salmon FMU) stocks necessary to meet the dual MSA objectives of obtaining optimum yield from a fishery while preventing overfishing. Each stock within the Salmon FMU has a specific objective, generally designed to achieve MSY, or MSP, or in some cases, an exploitation rate to serve as an MSY proxy. The Salmon FMP also specifies criteria to determine when overfishing is occurring and when a stock has become overfished. These conditions are referred to as a Conservation Alert and an Overfishing Concern, respectively. In addition, the Salmon FMP also specifies required actions when these conditions are triggered. The alternatives described in Section 2 are structured around the actions required when a Conservation Alert is triggered.

The annual management regime has been subject to several previous environmental impact analyses. From 1976 through 1983, the Council prepared an environmental impact statement (EIS) or supplemental EIS (SEIS) for each year's salmon fishing season. In 1984 an EIS was prepared when the Salmon FMP was comprehensively amended to implement the framework process for annual management. This resulted in a much more efficient management process and obviated the substantial staff burden of preparing an EIS or SEIS annually. A still more recent 2000 SEIS accompanied Amendment 14, implemented in 2001, which set the current Salmon FMU conservation objectives, and described the criteria and actions for a Conservation Alert and an Overfishing Concern. These EISs also represent information and analytical resources that, as appropriate, are incorporated into this document.

Historical Carrying Capacity of the Klamath River Basin for Fall Chinook (Hubbell and Boydstun 1985)

The number of natural spawners needed to maximize recruitment of KRFC was originally estimated at 41,000 to 106,000 adults (Hubbell and Boydstun 1985). Uncertainty over the capacity of the Basin for fall-run Chinook salmon led to the development of the harvest rate management policy for the stock that has been in place since 1989.

Recommended Spawning Escapement Policy for Klamath River Fall-Run Chinook (KRTT 1986)

This document reviewed four management policy options that were under consideration: 1) continue the current escapement goal of 115,000 adult spawners; 2) adopt respective goals for natural and hatchery spawners of 43,000 and 17,500 adult fish; 3) provide for two high escapements in the next six years to test the production response of the stock, and; 4) regulate the harvest rate consistent with the probable productivity of the stock. A single number escapement goal was not recommended because of uncertainty about the capacity of natural areas for spawning fish. Higher escapement levels than the 1978-1982 broods were needed to evaluate basin capacity for natural spawners. A probing approach was considered to achieve higher escapement levels, but was concluded to be too disruptive to the fisheries and probably not sufficient to clearly define the stock recruitment relationship. The harvest rate option was recommended for management purposes beginning in 1986. An escapement floor of 35,000 natural spawners was recommended to protect the production potential of the resource in the event of several consecutive years of adverse environmental conditions. This policy was the basis for the current Salmon FMP conservation objective for KRFC of a 35,000 naturally spawning adult escapement floor.

Pacific Coast Salmon Plan Amendment 9

Amendment 9 was approved in 1988 and implemented in ocean fishing regulations effective May 1, 1989. This Salmon FMP amendment codified the harvest rate management approach developed by the KRSMG and approved by the KFMC and PFMC. It called for the regulation of ocean fisheries to meet a spawner reduction rate of up to 65% (later increased to 67%) of each brood of KRFC except that 35,000 naturally spawning adults would be protected in all years. Various allowable ocean and river harvest rate combinations were specified in the Salmon FMP. The tribal and non-tribal harvest sharing agreement in effect at the time allowed for ocean and river harvest rates of up to 35% and 50%, respectively, based on age-4 fish (OSP 1986). The harvest rate approach was adopted because of uncertainty in the capacity of the Basin for fall-run Chinook salmon.

Population Dynamics of Klamath River Fall Chinook Salmon: Stock–Recruitment Model and Simulation of Yield under Management (KRTAT 1999)

The capacity of the Klamath Basin and productivity of the stock were analyzed in this study based on population simulation modeling using the Ricker stock recruitment function and available estimates of natural adult spawners and naturally produced age-3 recruits of the 1979-1993 broods. The naturally spawning adult runs could not be differentiated with regard to parental origin (which were likely significant in streams in the close vicinity of the two basin hatcheries). The Klamath River Technical Advisory Team (KRTAT) found a moderately good fit to the Ricker spawning-success submodel. The fitted Ricker curve relationship indicated the number of spawners needed to maximize production, weighted by age of fish, was 43,000 adult fish. The estimate of MSY was between 30,000 and 35,000 depending on level of precision in the stock abundance projections. They concluded that the 35,000 escapement floor was a near optimal choice in terms of fishery stability and long term yield. The use of a positive spawner reduction rate (SRR) to provide a small (*de minimis)* fishery in place of fishery closures was supported by simulation results, and suggested that a small SRR value of perhaps 10% -15% could be adopted at first, although study results did not show an adverse effect of a rate up to 20%. However, they were concerned that the higher value could substantially damage sub-stock structure of the species, which could not be explicitly modeled with the available data. The authors recommended that if a *de minimis* fishery were established, a maximum spawner reduction rate of 10% could be adopted, subject to review after a period of years.

Salmon Technical Team Report on the Technical Basis for the Klamath River Fall Chinook Conservation Objective (STT 2005a)

This report tracks the history and studies that have been conducted on the Conservation Objective for Klamath River fall-run Chinooks salmon, which is 35,000 naturally spawning adult fish. The report sites the Klamath River Technical Advisory Team report conclusion that "...the present spawner floor of 35,000 is prudent. Decreasing it seems unlikely to bring substantial increases in yield (and recommends) that the current spawner floor of 35,000 be retained."

Salmon Technical Team Stock-recruitment Analysis (STT 2005b)

The STT spawner-recruit analysis used natural stock data for the 1979-2000 broods of KRFC (see: http://www.pcouncil.org/bb/2005/0905/ag_g1.pdf). They analyzed the data using three different models: (1) all available stock and recruitment data, (2) all available data including an index of early juvenile hatchery fish survival, and (3) a habitat based model. As in the previous stock recruitment analysis, parental origin of adult spawners was unknown. The study found that Model 2 accounted for 80% of the density independent variation associated with the estimates of the logarithm of age-3 recruits compared to

56% for Model 1. Model 2 represented a more dome-shaped curve compared to the much steeper Model 1 curve, which resulted from inclusion of a survival term in Model 2. The Model 2 estimates of spawners for MSY, maximum production, and equilibrium production were: 40,700, 56,900 and 112,300, respectively. Model 3 was not considered appropriate because of the difficulty of separating contributions of hatchery and natural-origin fish to escapements and questions about the influence of dams and habitat conditions that affect stock productivity. Preliminary results for Model 3 suggested an MSY spawner level of 70,900 naturally spawning adults, nearly double the other models' estimates. The Council's Scientific and Statistical Committee (SSC 2005) reviewed this latest work and concluded that Model 2 was appropriate for current management of KRFC.

Pacific Coast Salmon Plan Amendment 13

It is difficult to compare management criteria for Chinook and coho salmon because of their substantially different life history patterns, but current management of OCN coho salmon provides an example of a level of *de minimis* fishing that is already allowed for Council stocks. Prior to the adoption of Salmon Plan Amendment 11, Oregon coastal natural (OCN) coho salmon were managed to meet an annual escapement of 200,000 adult spawners, except that an incidental catch rate of 20% was allowed when ocean stock size was estimated to be below 240,000 adults (see PFMC 1999). Amendment 13 changed the approach used for OCN coho salmon to one based on adult exploitation rate depending on parent stock size and ocean survival conditions. It reduced the maximum allowable exploitation rate for the stock under poor ocean survival conditions and low parent stock size to 15%, except that the rate could be reduced to below 13% under extremely adverse production and survival conditions (PFMC 1999).

Review of Ocean Salmon Fisheries

This document is the first in a series of annual documents prepared by the STT. It provides a historical context for fishery impacts, spawning escapement, and management performance for Salmon FMU stocks, annual regulations governing Council-area salmon fisheries, and economic factors associated with Council-area salmon fisheries. Information on inland marine and freshwater fisheries, as well as ocean fisheries in Canada and Alaska, are also presented. The 2005 document provides a baseline for fishery impacts and economic assessments used in this document. The most recent version of the review report for the previous year is available from the Council office beginning in late February.

Preseason Report I

This document is the second in the series prepared by the STT and presents projected stock abundances for Salmon FMU stocks, including the methodology and performance of predictors. The most recent version of the report is available from the Council office beginning in late February.

Preseason Report II

This report presents the range of regulatory ocean fishery alternatives that the Council was considering for the coming salmon season. It is distributed to the public and reviewed in public hearings to solicit public input of preferred management measures. The most recent version of the report is available from the Council office beginning in late March.

Preseason Report III

This is the final document in the series prepared by the STT. It details the final management measures adopted by the Council for recommendation to NMFS for the coming season's regulations. It includes an analysis of the effects of the management measures on conservation objectives for key Salmon FMU stocks, including the KRFC. The projected status of KRFC used in the analysis of the alternatives in this

EA is based on the analysis in Preseason Report III. The most recent version of the report is available from the Council office beginning in late April.

2006 Ocean Salmon Regulations EA (2006 Regulations EA)

The 2006 regulations EA analyzes the environmental and socioeconomic impacts of proposed management measures for ocean salmon fisheries occurring off the coasts of Washington, Oregon, and California. The document evaluated the 2006 annual salmon ocean harvest management measures with respect to compliance with the terms of the Salmon FMP, obligations under the Pacific Salmon Treaty (PST), and the level of protection required by all consultation standards for salmon species listed under the ESA. The range of alternatives analyzed in the 2006 Regulations EA included the effects of three levels of *de minimis* fishing strategies on KRFC when the stock was projected to fall below the 35,000 natural spawner floor for the third consecutive year. The escapement floor for naturally spawning KRFC was projected to not be attained even with complete closure of ocean salmon fisheries between Cape Falcon, Oregon, and Point Sur, California; therefore, the management measures required implementation by emergency rule. The NMFS-recommended 2006 salmon fishery management measures did not completely close fisheries between Cape Falcon and Point Sur, but limited fisheries to provide a minimum of 21,100 natural spawning adult KRFC in 2006. The 2006 EA supported NMFS' Finding of No Significant Impacts (FONSI) for the 2006 ocean salmon regulations.

West Coast Salmon Harvest Programmatic EIS (2003 PEIS)

This document evaluates how NMFS reviews annual salmon fishery plans in three jurisdictions, the North Pacific Fishery Management Council for Southeast Alaska; the PFMC for the Washington, Oregon, and California coast; and *U.S. v. Oregon* for the Columbia River Basin. In general, NMFS seeks to implement fisheries that are consistent with a variety of statutory and legal obligations related to resource conservation, socioeconomic benefits associated with resource use, and treaty trust obligations. Fishery plans are developed annually within the context of framework plans to meet the year-specific circumstances related to the status of stocks affected by the fisheries. This final 2003 PEIS evaluates different ways to balance these objectives and different strategies that can be used that may provide better solutions for meeting the obligations and objectives of the respective framework plans. The alternatives considered in this final PEIS are programmatic in nature and are designed to provide an overview of fishery management methods and strategies that can be implemented as part of the annual planning processes.

Area 2A Pacific Halibut Catch Sharing Plan

A catch sharing plan for Pacific halibut in area 2A (southern U.S. waters) was developed in 1995 to allocate the halibut quota among various user groups and geographic areas. The catch sharing plan included, among other things, an annual allocation of Pacific halibut for the non-Indian commercial salmon fishery, to be taken incidentally during Council-area fisheries. This EA also assesses the impacts of the commercial salmon fishery on the halibut resource.

2005-2006 Groundfish Fishery EIS

The 2005-2006 Council-area groundfish fishery management measures were the subject of an EIS that included the likely effects of Council-area recreational and commercial salmon fisheries on important groundfish stocks. Alternative management measures for salmon fisheries were analyzed, but no modifications to salmon fisheries were recommended, due to the insignificant impacts on groundfish stocks of concern.

KRFC Review Team Report (PFMC 1994)

The Council appointed a Klamath River Fall Chinook Review Team (Team) to review the cause of escapement floor (Conservation Objective) shortfalls of KRFC that occurred in 1990, 1991, and 1992. This "overfishing review" identified several reasons for the spawner escapement failures, but the lack of natural fish data made it impossible to identify a primary cause in each case. The Team arrived at five broad categories of causal factors that contributed to the three-year failure to meet the spawner escapement goal:

1. Poor survival conditions in the marine environment,
2. Inaccuracies in harvest management methodologies,
3. Low stream flows, exacerbated by drought,
4. Improper hatchery release practices, and
5. Degraded spawning and freshwater rearing habitats.

The Team had several management recommendations. The CDFG and Council have implemented some of these including (response in parentheses):

1. Recalibration of the KOHM (cohort reconstruction updates are done annually),
2. Elimination of the bias in the regressions used to project ocean abundance levels (all regressions are now run through zero), and
3. Minimize hatchery and natural fish interactions (hatcheries now limit egg-takes and prohibit stocking of pre-smolts from both facilities).

Since the Team Report was published additional concerns have developed for Klamath Basin salmonid resources. These include 1) widespread presence of diseased juvenile salmonids in main stem reaches, primarily during summer months, and 2) the practice of denying admittance of adult fish into Klamath Basin hatcheries once egg take needs are met. The disease problem has been a recurring situation, but the practice of closing ladder racks was ended at both hatcheries starting with the 1996 spawning season.

1.4.4 Scoping Summary

During the 2005 process to set annual ocean salmon fishing regulations, it became apparent that the KRFC Conservation Objective of no less than 35,000 naturally spawning adults would be the primary constraint on fisheries south of Cape Falcon, Oregon. Fishing opportunity, commercial in particular, would be limited to about 60% of 2004 fisheries despite a record high forecast of California Central Valley Chinook salmon stocks. The Council discussed the possibility of utilizing an emergency rule to allow fishing below the KRFC floor to provide access to abundant Central Valley Chinook salmon stocks, but eventually decided not to pursue that option. The Council did, however, initiate an examination of the KRFC floor by requesting the STT investigate the technical basis for the KRFC conservation objective, and in particular the 35,000 floor.

At the June 2005 Council meeting, the STT informed the Council that the objective in the Salmon FMP is "to allow a wide range of spawner escapements from which to develop an MSY objective or proxy while protecting the stock during prolonged periods of reduced productivity," and was generally based on simulation modeling assessing the yield in fisheries given various recruitment scenarios and values for the floor (STT 2005a). At the time FMP Amendment 9 was adopted in 1988, there were only six complete broods available for a stock/recruitment analysis. However, a subsequent evaluation of the escapement floor conducted in 1999 by the KRTAT (KRTAT 1999) reaffirmed that retention of the 35,000 natural adult escapement floor would likely increase long term average yield (STT 2005a).

The Council noted that there would be at least six years of additional information available since the 1999 review, and requested the STT follow-up with an updated analysis including recent year stock recruitment information and an estimate of MSY, as described in the Salmon FMP. The Council also requested the STT investigate the relationship between recruitment and river flows during both spawning and juvenile rearing phases. The STT was to report back to the Council in September 2005, and pending the results, the Council would consider initiating an amendment to the Salmon FMP to update the KRFC conservation objective.

At its September 2005 meeting, the STT presented its KRFC stock recruitment report, which displayed results for three different stock recruitment models (STT 2005b). The Council deferred a decision to consider revision of the KRFC conservation objective through an FMP amendment until the November 2005 Council meeting. The deferral was to allow the Council to consider additional information from four areas: (1) potential comments from the KFMC on the STT's analysis of stock-recruitment relationships (STT 2005a), and on possible initiation of an FMP amendment; (2) SSC review of the STT analysis; (3) a report from NMFS regarding any changes in application of Federal emergency regulatory flexibility to the current KRFC conservation objective; and (4) implication of a possible *Ceratomyxa shasta* epidemic and other pathological conditions in the Klamath Basin.

At the November 2005 Council meeting, the KFMC reported they and the KRTAT had reviewed the STT report on KRFC Stock-Recruitment Analysis (STT 2005b) and found the technical basis of the analysis was sound. The KFMC concurred with the STT and SSC recommendations of using a stock-recruitment model that incorporated a juvenile survival parameter to represent KRFC stock dynamics (Model 2 in the STT analysis). The juvenile survival parameter was intended to reflect density independent factors such as estuary and early marine survival. The KFMC concluded that the Salmon FMP conservation objective for KRFC of a 67% maximum spawner reduction rate and a minimum 35,000 fish natural spawning escapement floor was appropriate and reflected the uncertainty inherent in the STT's stock-recruit analyses. The KFMC recommended the Council proceed with an FMP amendment process, confined in scope to addressing the potential for *de minimis* fisheries. The KFMC also recommended that any such amendment be based upon a prudent, precautionary approach regarding the protection of substocks within the Klamath Basin, and should be scaled to projected stock abundance.

Based on the KRTAT analysis (KRTAT 1999), the KFMC recommended that whenever "without fishing" natural spawner abundance was predicted to be 39,000 or less, *de minimis* fisheries could be considered, with a maximum spawner reduction rate of 10%, and that the *de minimis* fishing rate reduce linearly from 10% to 0% as a function of projected stock abundance. The KFMC also recommended that whenever *de minimis* fisheries were adopted, a technical review of the anticipated escapement shortfall should be completed prior to the adoption of regulations for the following season. If fishery impacts were found to be a major cause of a substantial shortfall, *de minimis* fisheries should not be proposed in that subsequent season.

After hearing from the KFMC, SSC, NMFS, and the Salmon Advisory Subpanel (SAS) at its November 2005 meeting, the Council approved initiating an FMP amendment to consider allowing *de minimis* fishery impacts when the escapement objective of 35,000 KRFC natural spawners could not be achieved with a normal fishery management response. The Council set an initial scoping meeting for the March 2006 Council meeting.

At its March 2006 meeting the Council limited the scope of the amendment process to two issues:

1. Modifying the criteria and Council Action for a Conservation Alert; and
2. Modifying the Klamath River fall Chinook salmon conservation objective.

The intent of the FMP amendment would be to address implementation of *de minimis* fisheries associated with depressed stock status and necessary FMP verbiage changes to implement the initiative.

The Council identified three possible alternatives to be analyzed:

1. Use of a sliding scale for a spawner reduction rate as suggested by the KFMC;
2. Prescribing an exploitation rate level (5% or 10% were cited) below which fisheries could be prosecuted without significant impact on stocks of concern; and
3. Use of an exploitation matrix that takes into account such things as the abundance of the stock in question, the abundance of co-mingled healthy stocks, and technical uncertainty.

At its June 2006 meeting, the Council narrowed the scope of the amendment to only consider (1) *de minimis* fisheries related to KRFC stock status and (2) eliminate the use of an exploitation matrix, as described above, because inclusion of a second stock in the analysis greatly complicates the analysis and should not be attempted until the components of the matrix can be evaluated individually and collectively (see http://www.pcouncil.org/bb/2006/0606/agg2b_supp_sac.pdf) The Council adopted a range of alternatives to amend the FMP to provide *de minimis* fishing opportunity during periods when the status of KRFC is such that no fishing opportunities would be allowed under the current FMP. The alternatives included:

1. Status quo (no fishing)
2. A sliding scale allowing increasingly lower total ocean and river fishery impacts (catch + incidental mortality) as stock abundance decreases;
3. Less than or equal to a 5% age-4 ocean impact rate; and
4. Less than or equal to a 16% age-4 ocean impact rate.

The Council directed analysis of two features in concert with the above alternatives: (1) a rebuilding feature that would limit *de minimis* fisheries to no more than three consecutive years, with a minimum of three consecutive years with escapement above the 35,000 natural spawner floor before additional *de minimis* fisheries could occur; and (2) the prohibition of any fall/winter fisheries (September 1 through March 15) when *de minimis* fisheries take place.

The Document Subcommittee met and analyzed the Council's alternatives during July 2006 and met with the full Salmon Advisory Committee on August 9, 2006 to review the second draft amendment.

At its September 2006 meeting, the Council narrowed the range of alternatives under consideration for Amendment 15 after receiving reports from the SAC, the SSC, the SAS, the STT, and testimony from the public. The Council adopted for public review the following four alternatives for Salmon FMP Amendment 15:

1. Status quo (no fishing);
2. A 5% cap on the age-4 ocean impact rate;
3. A 10% cap on the age-4 ocean impact rate;
4. A 13% cap on the age-4 ocean impact rate.

The Council also eliminated from consideration the following four Alternatives:

1. A 16% ocean impact rate cap – It was felt this alternative was too similar to current management under which a 16% age-4 ocean harvest rate limit on KRFC is used as an ESA consultation standard for threatened California coastal (CCC) Chinook. Therefore, it provided sufficient reduction in harvest impacts when KRFC were depressed. This alternative also represents an impact level greater than was assumed for management of 2006 ocean fisheries, which required an emergency rule to implement. The Council felt the 2006

ocean impact rate of approximately 13% represented an upper bound for consideration in this amendment.

2. The Sliding Scale Alternative. This alternative was functionally similar to the 5% Cap Alternative in that it took effect at about a 4% ocean impact rate, and as a cap, it allows the Council to scale back impacts based on stock status like the sliding scale alternative. The range of adopted alternatives also encompassed the sliding scale impact rates, so the analytical work could be reduced by eliminating this alternative without reducing potential implementation features.
3. A rebuilding feature that would prohibit *de minimis* fishing in the fourth year commencing March 15 following three consecutive years of de minimis fishing in which the escapement floor was not met, and prohibit *de minimis* fishing thereafter until the escapement floor was met for three consecutive years. This "rebuilding" feature was highly prescriptive and complicated because of the many possible combinations of *de minimis* and non-*de minimis* fishing events and whether the natural escapement floor is met in those same years; and because it would specify outcomes for future years that would likely be superseded by recommendations from overfishing reviews. The latter point was a particular concern with the second clause of this alternative.
4. The prohibition of any fall/winter fisheries (September 1 through March 14) following spring/summer (March 15 to August 31) *de minimis* fisheries. This alternative did not take into account the significance of fishery impacts in fall/winter fisheries by time and area. Some fall/winter fisheries have lower impacts on KRFC than others, and probably higher economic importance than some spring/summer fisheries.

The Council is currently able to take the actions prescribed in the last two alternatives, eliminated from consideration, if the specific circumstances indicate they are necessary. However, if either of these two alternatives were alternatives were Council flexibility would be reduced, which was not the intent of Amendment 15 as indicated in the statement of purpose and need.

The Council delayed selection of a preferred alternative until the November 2006 Council meeting in San Diego, but reaffirmed its intention to take final action on Amendment 15 at that meeting, maintaining the overall objective of completing the amendment process in time for implementation by the start of the 2007 salmon management season on May 1. A preliminary draft EA for of Amendment 15 was released October 25, 2006. Public hearings to receive input on the alternatives were scheduled for November 1, 2006 in North Bend, Oregon, and Arcata, California, and November 2, 2006 in Santa Rosa, California. The exact locations and times for the public hearings were posted on the Council web site, or were available by contacting the Council office. Public testimony will also be received at the November 17, 2006 Council meeting in Del Mar, California.

1.5 Relevant Issues

In addition to the scoping activities described above, previous environmental impact analyses for Council-managed salmon fisheries, and other Council documents, are a valuable resource that can be used to narrow the scope of this analysis to potentially significant issues. These documents present issues the proposed action is likely to affect and aspects of the environment that may have changed since the completion of previous analyses. Agency guidance, in the form of NOAA Administrative Order 216-6, Environmental Review Procedures for Implementing the National Environmental Policy Act (NEPA), is a good starting point for identifying potentially significant issues. Section 6.01, which parallels NEPA implementing regulations (40 CFR 1508.27), lists 11 factors that should be used to determine the significance of any major action taken by NOAA. These are:

- Impacts may be both beneficial and adverse -- a significant effect may exist even if the Federal agency believes that on balance the effect will be beneficial.
- Degree to which public health or safety is affected.
- Unique characteristics of the geographic area.
- Degree to which effects on the human environment are likely to be highly controversial.
- Degree to which effects are highly uncertain or involve unique or unknown risks.
- Degree to which the action establishes a precedent for future actions with significant effects or represents a decision in principle about a future consideration.
- Individually insignificant, but cumulatively significant impacts.
- Degree to which the action adversely affects entities listed in or eligible for listing in the National Register of Historic Places, or may cause loss or destruction of significant scientific, cultural, or historic resources.
- Degree to which endangered or threatened species, or their critical habitat as defined under the Endangered Species Act of 1973, are adversely affected.
- Whether a violation of Federal, state, or local law for environmental protection is threatened.
- Whether a Federal action may result in the introduction or spread of a non-indigenous species.

Section 6.02 of the Order enumerates a more specific set of guidelines for identifying potentially significant environmental impacts resulting from a fishery management action. These are:

- The proposed action may be reasonably expected to jeopardize the sustainability of any target species that may be affected by the action.
- The proposed action may be reasonably expected to jeopardize the sustainability of any non-target species.
- The proposed action may be reasonably expected to cause substantial damage to the ocean and coastal habitats and/or essential fish habitat as defined under the MFCMA and identified in FMPs.
- The proposed action may be reasonably expected to have a substantial adverse impact on public health or safety.
- The proposed action may be reasonably expected to adversely affect endangered or threatened species, marine mammals, or critical habitat of these species.
- The proposed action may be reasonably expected to result in cumulative adverse effects that could have a substantial effect on the target species or non-target species.

- The proposed action may be expected to have a substantial impact on biodiversity and ecosystem function within the affected area (e.g., benthic productivity, predator-prey relationships, etc).

- If significant social or economic impacts are interrelated with significant natural or physical environmental effects, then an EIS should discuss all of the effects on the human environment.

- A final factor to be considered in any determination of significance is the degree to which the effects on the quality of the human environment are likely to be highly controversial. Although no action should be deemed to be significant based solely on its controversial nature, this aspect should be used in weighing the decision on the proper type of environmental review needed to ensure full compliance with NEPA. Socioeconomic factors related to users of the resource should also be considered in determining controversy and significance.

Both sets of guidelines are used in this assessment, but in different ways. The Section 6.02 guidelines are resource or topic specific and have been used to structure the analysis and screen for environmental components and effects that should be evaluated. Within this framework, effects are evaluated based on the 11 factors listed in Section 6.01, as relevant.

As noted above, thorough scoping of the EA process should focus on those environmental components likely to be affected by the proposed action. NAO 216-6 Section 6.02 guidelines are used as a screen. If equivalent effects have already been considered in a previous environmental document, and the condition of an environmental component has not changed substantially in ways that would make it more likely that the proposed action could significantly affect it, then that component is screened out from consideration. In this way, effects known not to be significant and resource components known not to be affected can be eliminated from consideration. This screening process is summarized below.

<u>6.02(a) - Salmon FMU</u>: KRFC is a key stock in the Salmon FMU, and frequently limits fisheries between Cape Falcon, Oregon and Point Sur, California. The objective of this amendment is to allow fisheries to occur during temporary periods of depressed KRFC status without jeopardizing the long term productivity of KRFC. This EA uses, in part, an age structured stochastic stock recruitment model (SSRM) to estimate the effects of alternative management strategies on the KRFC population, and compares results among alternatives using probabilities of population events such as the stock becoming overfished, spawning escapement below certain thresholds, and meeting hatchery egg collection goals. The management alternatives being considered directly affect Salmon FMU populations because ocean fisheries operate on mixed stocks, and the weakest stock in any one year limits access to healthier stocks. However, because these alternatives only consider management options from the perspective of KRFC as the weakest stock, significant impacts to other Salmon FMU stocks are not likely. Therefore, determination of potentially significant effects to Salmon FMU stocks evaluated in this EA is limited to KRFC. While the SSRM provides estimates of the probability of certain events for the various alternatives, there are no established critical levels on which to test for significance. Models such as the SSRM have characteristics that make relative comparisons more appropriate for this type of analysis. Therefore, the analysis will focus on the relative differences in alternatives in comparison to the Status Quo Alternative.

The criteria for KRFC used to assess the relative merits of the alternatives compared to the Status Quo Alternative were as follows:

1) Probability of a natural spawning escapement lower than any historically observed (12,000).

At some lower level of spawning escapement, depensatory effects are likely to occur, which could result in extirpation of subpopulations, genetic drift, or other factors potentially reducing the long-term productivity of the stock. The natural spawning escapement of KRFC reached this level twice (1991 and 1992) and recovered in terms of abundance; however, the effect on the intrinsic productivity of the stock is unknown. While it is difficult to quantify the depensatory relationship or threshold, the risk is likely to increase at escapements below the historical low.

2) Probability of any of the major mid-Klamath Basin substock (Shasta, Scott, or Salmon rivers) having a natural spawning escapement of less than 720 adults in any year.

Conservation biologists, who are concerned with the extinction of populations and species, often use an effective population size of 500 adults per generation as a general rule of thumb for the minimum size of a population (Appendix D). Populations with an effective size less than 500 may lose diversity in quantitative traits faster than it can be replaced by mutation. Effective population is always smaller than the actual number of breeders because only a fraction reproduces successfully. Chinook salmon mature at ages-3, -4, and -5, so calculating the number of spawners needed in any given year to achieve an effective population size for the brood requires some assumptions regarding the characteristics of the stock (see Appendix D). For distinct population segments within the Klamath Basin, the annual spawning escapement needed to achieve an effective population size of 500 spawners was estimated to be720 adults in any one year. The fall Chinook salmon runs in the Shasta, Scott and Salmon rivers represent unique adaptations and genetic resources that are important to conserve in order to maintain the productivity of the aggregate KRFC stock. The runs in the Shasta, Scott and Salmon rivers have been monitored annually since 1978 and have occasionally fallen below 720 adult spawners in any year. There are other important naturally spawning fall Chinook salmon substocks in the Klamath and Trinity basins, but annual run size monitoring has been inconsistent or non-existent for these populations. The Shasta, Scott, and Salmon rivers are therefore used as indicators to address the general concern about the effects of management alternatives on substocks of KRFC.

3) Probability of a spawning escapement below the 35,000 natural spawner floor in any year.

The MFCMA is clear that management plans and fishery regulations shall prevent overfishing (see: http://www.nmfs.noaa.gov/sfa/magact/mag3.html#s301). While the intent of this amendment is to allow some fishing at spawning escapement levels less than the 35,000 floor, the application of *de minimis* fisheries would insure the long-term productivity of KRFC was not jeopardized due to the level of fishing allowed, and the stock would be able to rebuild from a state of temporary depression while still allowing continued participation of the fishing community. This amendment would not affect the threshold for triggering an Overfishing Concern currently in the FMP, which is three consecutive years of a stock failing to meet its conservation objective.

4) Probability of three consecutive years of spawning escapement less than the 35,000 floor within a 40-year time period.

The intent of this amendment is to provide opportunity for *de minimis* fisheries during temporary stock depression, while not increasing the probability of the stock becoming overfished. If stock depression continues for three years, an Overfishing Concern would be triggered, and additional measures may become necessary to rebuild the stock. This would represent a potentially significant change in management strategy. However, due to the current status of KRFC (i.e., KRFC have not met the conservation objective for two consecutive years and are not expected to meet the objective for a third), the stock will be considered, for the purpose of this analysis, overfished at the beginning of the simulation period.

5) Probability that hatchery egg collection goals will be met every year.

KRFC production at the two Basin hatcheries, Iron Gate and Trinity River, is an important component of harvest and natural spawning escapement in the area of the hatcheries. The current conservation objective for KRFC includes a 35,000 natural spawning adult floor, which was intended, among other things, to provide assurance that hatchery egg take goals would be met. The current egg take goals are 10,000,000 eggs for Iron Gate Hatchery and 6,000,000 eggs for Trinity Hatchery, which equate to a total of about 13,000 adult salmon. Any proposal resulting in lower natural spawning escapement should also be evaluated relative to the objective of meeting the egg take goal.

6.02(b) - Non-target Species: Commercial salmon trollers catch a range of species aside from salmon, albeit in low numbers. The 2000 SEIS (Section 5.2.3) found that the impacts of the fishery on fish other than salmon were not significant. Characteristics of the salmon fishery, such as changes in gear or method of deployment (including time and area) have not changed substantially since the SEIS was completed; however, the status of some of the non-salmon fish stocks taken as incidental catch has changed. For example, there are currently seven groundfish species that have been declared overfished and for which rebuilding plans have been developed: bocaccio, cowcod, darkblotched, canary, widow, and yelloweye rockfish, and Pacific Ocean perch. These and other groundfish species are managed under the Council's Groundfish FMP. Under this plan, biennial management measures are established for these species, and an environmental impact analysis is prepared in connection with that process, which also covers landings in the ocean salmon fishery. The EIS for 2005-2006 groundfish management measures found that catch levels for target salmon fisheries would not have a significant impact on overfished groundfish species. The 2006 Regulations EA also analyzed the impacts of the ocean salmon fishery on groundfish stocks, which resulted in a FONSI. *Therefore, no further consideration of effects on groundfish will be given in this EA.*

Pacific halibut (*Hippoglossus stenolepis*) is also incidentally caught in the salmon fishery, but continues to be a healthy stock. During its March and April meetings, the Council sets management measures for incidentally-caught Pacific halibut in the commercial salmon fishery. Halibut are demersal (bottom-dwelling) fish that may be caught by fisheries that target salmon. The International Pacific Halibut Commission (IPHC) manages halibut fisheries throughout the entire North American range of the fish (Alaska, British Columbia, and the U.S. West Coast) by means of allocated catch quotas. (More information on the IPHC and halibut life history and management is available from the IPHC website, http://www.iphc.washington.edu/halcom/.) The allocation, established annually by the IPHC for the West Coast (referred to as Area 2A in the IPHC's scheme of management zones), is subdivided among various user groups according to a catch sharing plan developed by the Council. This plan allocates 15 percent of the non-Indian commercial halibut allocation in Area 2A to the salmon troll fishery incidental catch during May and June (with provision for additional harvest from July through September if sufficient quota remains). In 1994, an EA was prepared for the catch sharing plan that allocates halibut catch among West Coast fishing sectors. The catch sharing plan is modified annually, or as necessary to accommodate changes, and an EA or Categorical Exclusion is prepared. Incidental catch in the salmon fishery in 2006 falls under terms of this plan, and impacts are not different from those analyzed in the EAs, which concluded they are not significant. *Therefore, no further consideration of effects on Pacific halibut will be given in this EA.*

6.02(c) - Affected Habitat Including Essential Fish Habitat (EFH): Appendix A of Amendment 14 to the Salmon FMP (EFH Appendix A) describes salmon EFH and fishing and non-fishing impacts to this habitat. Non-fishing impacts to salmon habitat have been extensive and significant (see pages A-62 to A-110 in EFH Appendix A). However, this EA is considering changes to ocean salmon management strategies, which do not affect the activities that cause these impacts. Because EFH impacts are extensively described and analyzed in EFH Appendix A, and this analysis demonstrates the ocean salmon fishery has no significant impacts, *EFH will not be considered further in this EA.*

6.02(d) - Biodiversity and Ecosystem Function: This EA considers changes to ocean salmon fishery management strategies, which could allow more fishing effort and harvest for Salmon FMU stocks in some seasons. The 2000 SEIS discusses impacts of the ocean salmon fishery to higher trophic level species including seabirds (Section 5.2.4 and 5.2.5 on pages 5-5 to 5-7) and lower trophic level species (Section 5.2.6 on page-5-7). Higher trophic level species affected by the salmon fishery include marine mammals, particularly harbor seals (*Phoca vitulina)* and California sea lions (*Zalophus californianus)*. Salmon form a part of the diet of these animals, so marine mammals may compete with fisheries for this resource. Harbor seals and sea lions are opportunistic feeders and, in general, their populations have been increasing. (However, some other species of marine mammals' populations have been declining.) According to the 2003 PEIS (pages 4-42 to 4-44), Pacific Coast fisheries have a minimal impact on marine mammals, which is mitigated by NMFS education programs aimed at vessel operators. Both the 2000 SEIS and 2003 PEIS found that direct impacts on seabirds are minimal to non-existent. Indirect impacts, due to competition for salmon and the availability of processing offal as a food source were determined to be minimal. The SEIS notes that "any amount of harvest removes animals that otherwise would have remained in the ecosystem" to prey on lower trophic levels. However, it concludes that fishery removals are not significant in this respect and wide-scale changes in oceanographic conditions, resulting from *El Niño* events for example, are the primary determinants of abundance and structure of lower trophic level populations.

An increase in salmon harvest would decrease the number of adult salmon returning to freshwater spawning areas. This in turn can affect the availability of salmon carcasses to predators, scavengers, and decomposers, and reduce nutrient transport to inland environments. Maintaining biodiversity and ecosystem function, by conserving evolutionarily significant salmon stocks, is a key management goal. Since biodiversity and ecosystem function impacts correlate with fishing mortality to depressed and ESA-listed wild stocks, these impacts can be addressed in assessing impacts to target stocks, as discussed above. Based on the analysis in the 2000 SEIS and 2003PEIS, and the correlation between fishing mortality and stock impacts, biodiversity and ecosystem impacts will not be separately considered in this EA.

6.02(e) - Protected Species Interactions: Section 5.2.4 of the 2000 SEIS, referenced above, also discusses direct interactions between marine mammals and ocean salmon fishing vessels. These interactions include vessels approaching these animals, marine mammals feeding on hooked salmon, and rarely, animals that become hooked by or snagged in the gear. The 2000 SEIS concludes that these interactions do not constitute a significant impact; the document also notes that these fisheries are classified under the Marine Mammal Protection Act as Category III, indicating there is no record of such impacts. Other listed species that might be affected by the salmon fishery include sea turtles, certain seabirds, and southern resident killer whales. The 2000 SEIS considered possible impacts to sea turtles and seabirds and determined they were not significant.

Southern resident killer whales were listed as endangered under the ESA effective February 17, 2006. Chinook salmon have been identified as a primary prey for this population of killer whales. NMFS issued a BO dated June 6, 2006, completing a Section 7 consultation on the effects of Council area salmon fisheries on southern resident killer whales and determined the anticipated Council area fisheries would not jeopardize the continued existence of the southern resident killer whale evolutionarily significant unit (ESU). Therefore, interactions with these protected species will not be further considered in this EA.

Various salmon, steelhead, and trout stocks or ESUs [4] that are potentially caught in the ocean salmon fishery are listed under the ESA. Since 1992, NMFS has issued BOs indicating ocean salmon fisheries do not jeopardize the continued existence of ESA-listed salmonids or adversely affect their critical habitat (see Section 5.3.2 for a list of relevant BOs). This determination has been reached through the Section 7 consultation or Section 4(d) determinations process, pursuant to the ESA. This process establishes a set of "consultation standards" the fishery must satisfy in order to avoid a determination that the action jeopardizes the continued existence of a listed salmonid ESU. ESA consultation standards must be considered when developing management strategies because the proposed action constrains harvest levels in response to stock status, conservation objectives, and legal obligations. As noted above, listed salmon stocks are also components of the target species, but *ESA-listed stocks are considered separately under the protected species heading.*

Management of ocean salmon fisheries contemplated in this EA are intended to comply with ESA consultation standards for listed salmon ESUs. CCC salmon are particularly important to consider as part of this initiative because age-4 KRFC are used as a surrogate for assessing ocean fishery impacts on CCC salmon. A criterion of greater than 50% probability of exceeding an age-4 ocean harvest rate on KRFC was used in this EA to evaluate the significance of alternatives for meeting the terms of the NMFS consultation standard for CCC salmon.

<u>6.02(f) - Public Health and Safety</u>: Fisheries management can affect safety if, for example, season openings make it more likely that fishermen will have to go out in bad weather because fishing opportunities are limited. The EA that was incorporated into Amendment 8 to the FMP analyzed alternatives to adjust management measures if unsafe weather affected fishery access. The Council's Preferred Alternative in the Amendment 8 EA was the No Action Alternative, under which weather-related issues are considered during inseason adjustments to management measures. The range of alternatives considered for the proposed action would be within the range described in that EA. *Since these types of potential impacts have been previously analyzed and found not to be significant, they are not discussed further in this EA.*

<u>6.02(g) - Socioeconomic Environment</u>: As noted above, socioeconomic effects are a primary justification for considering alternative salmon fishery management strategies and are closely interrelated with environmental effects (see also 40 CFR 1508.14). The 2000 SEIS describes how management measures that could be part of the proposed action have interrelated economic and environmental effects. Allocation of fish between different user groups is the main socioeconomic factor the Council considers when formulating annual management measures. Since management measures with these interrelated effects change from year to year, and they may cause potentially significant impacts, this EA considers certain socioeconomic effects. Overall harvest opportunities, and those related to allocation, can affect some communities more than others. Disproportional impacts to particular communities resulting from the alternatives are described. The social and economic impacts of the alternatives being considered were compared using:

1. Relative ocean recreational salmon fishery economic impacts,

2. Relative troll fishery economic impacts,

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[4] An ESU constitutes a "distinct population segment" for the purposes of listing, delisting, and reclassifying species under the ESA. (See 61 FR 4722 for the current policy on recognizing distinct population segments.)

3. Probability of meeting Tribal fishery subsistence need,
4. Relative Tribal fishery economic impacts, and
5. Relative river recreational fishery economic impacts

The geographic scope of ocean fishery impacts was limited to the area between Cape Falcon, Oregon and Point Sur, California, as observed tag recoveries of KRFC are rare outside this area. In addition, tag recoveries occurring north of Cape Falcon and south of Point Sur (less than 1% of KRFC tags on average) are included in annual impact assessments of the adjacent area used in the KOHM to forecast future impacts. In years when KRFC triggered a conservation alert (1992 and 2006), fisheries outside the Cape Falcon to Point Sur area were not restricted because the probability of impacting KRFC was considered insignificant.

6.02(h) - Cumulative Effects: This class of effects is usually considered separately, because it requires consideration of the impacts of other Federal and non-Federal past, present or reasonably foreseeable actions, other than the proposed action, that affect the resources of concern. The incremental effects of these many actions may be collectively significant. In the context of salmon management, for example, past and “reasonably foreseeable” salmon management practices should be considered. The effect of management strategies for the ocean salmon fishery in any given year should be assessed with past and future annual regulations, since they affect a given population cohort. Although habitat impacts have been considered in previous documents, the cumulative effects of these impacts, when combined with fishing permitted under Council authority, should also be assessed. The 2003 PEIS (NMFS 2003) provides a comprehensive summary of cumulative effects regarding West Coast salmon, including a general inventory of actions known to adversely affect salmon habitat and a list of the factors for decline of ESA-listed species. It examines the degree to which harvest can be expected to contribute to recovery of depressed stocks and the degree to which necessary survival improvements will have to come from other sources of human-induced mortality. It also provides examples of current remedial activities designed to improve the status of salmon stocks. Recent proposals to change Klamath Basin flow regimes may, if implemented, change the production potential of naturally spawning stocks, which may not be reflected in existing stock recruitment data. It is beyond the scope of this initiative to speculate on possible changes in stock productivity that may occur with future flow regime changes or other freshwater habitat changes.

6.02(i) - Controversy: The final factor, controversy, is not by itself a basis for determining significance. Like other more general factors it is considered during EA preparation, but is not used to structure the analysis. Controversy is not a preference for action or no action, but rather concerns legitimate disagreements over the process and results of the effects analysis (e.g., “best available” science).

The screening process described above focuses the impact assessment in this EA on those components of the human environment for which further analysis is needed to determine whether there is a potential significant impact stemming from implementing the proposed action. As noted previously, if it is determined the proposed action has the potential to significantly impact the quality of the human environment, then either the proposed action must change or an EIS must be prepared. Conversely, if based on this EA, NMFS concludes the proposed action will not have significant impacts, that determination is disclosed in a FONSI and an EIS need not be prepared. It should be noted that the evaluation of the alternatives may result in determining one or more of the alternatives have significant impacts. However, the Council may adopt for public review alternatives that do not meet all relevant objectives, so as not to restrict the range of possible Preferred Alternatives.

2.0 DESCRIPTION OF ALTERNATIVES

2.1 Alternatives for Klamath River Fall Chinook Salmon Management

At its September 2006 meeting, the Council settled upon the four *de minimis* fishing alternatives (Table 2-1). All alternatives include the CCC salmon consultation standard of ≤ 16% ocean harvest rate on age-4 KRFC.

Table 2-1. *De minimis* fishing level alternatives for KRFC adopted by the Council at its September 2006 meeting.

Alternative	Description	Comment
1 – Status Quo (no action)	No *de minimis* rate expressed. Impacts determined by 66-67% annual adult spawner reduction rate[a/] (SRR) except not less than 35,000 natural adult spawners in any year, and compliance with the ESA consultation standard for California Coastal Chinook (CCC) salmon of an age-4 ocean harvest rate (OHR) of ≤ 16.0% on KRFC.	No ocean fisheries between Cape Falcon, Oregon and Point Sur, California if the 35,000 adult spawner floor could not be achieved.
2 – 5% Cap	≤ 5% annual age-4 ocean impact rate for projected natural adult spawners absent fishing of less than about 40,000 (12.5% SRR) and compliance with the CCC salmon consultation standard	This rate may be substituted for the 35,000 floor, but does not replace it for issuing Overfishing Concerns.
3 – 10% Cap	≤ 10% annual age-4 ocean impact rate for projected natural adult spawners absent fishing of less than about 47,000 (25% SRR) and compliance with the CCC salmon consultation standard	This rate may be substituted for the 35,000 floor, but does not replace it for issuing Overfishing Concerns.
4 – 13% Cap	≤ 13% annual age-4 ocean impact rate for projected natural adult spawners absent fishing of less than about 52,000 (33% SRR) and compliance with the CCC salmon consultation standard	This rate may be substituted for the 35,000 floor, but does not replace it for issuing Overfishing Concerns.

a/ Spawner reduction rate as used by the Klamath River Technical Advisory Team is an annual rate computed as the number of potential adult natural spawners (aka: "adult equivalents" or "ocean adults") impacted in ocean and river fisheries divided by the initial number of potential natural adult spawners in the ocean at the start of the biological year for KRFC (September 1). "Impact" includes landed catch plus shaker and drop off mortalities.

2.1.1 Status Quo Alternative

The current escapement goal for the stock is to allow up to a 67% spawner reduction rate (SRR) annually except that a minimum of 35,000 naturally spawning adult spawners shall be protected in all years. The 35,000 floor was specifically protected from modification except by FMP amendment. The harvest rate approach for KRFC was adopted in 1988 in lieu of sufficient biological information for setting a MSY based objective, and was expected to provide a range of escapement levels that could be used for estimating MSY. However, it should be noted that modification of the floor to some other value would not address the issue of *de minimis* fishing opportunity in low abundance years, which is a primary reason for the current FMP amendment effort.

Adoption of the Status Quo Alternative or cessation of this amendment process places the onus of adopting annual salmon fishing regulations during low stock abundance years on the emergency rule process of the MSA as implemented by NMFS. As experienced in 2006, the NMFS emergency rule process results in considerable uncertainty in the final regulations, which may not be decided by the PFMC and NMFS until the last few days of the annual salmon regulation process, and is likely to deviate from many fishermen's and manager's expectations for the coming season. Looking to the 2007 season and beyond, the expectation is that low abundance of KRFC could persist through 2009. This protracted projection of low stock abundance stems from low flows and associated high water temperatures that occurred in the river through the summer of 2004 (affecting the 2001-2003 broods), poor marine survival conditions affecting the 2004-2005 broods, and high ocean exploitations rates associated with unusual ocean distribution of KRFC during 2003-2005 (affecting the 2003-2005 broods) (SSC 2006).

2.1.2 Fixed Harvest Impact Rate Alternatives

At its September 2006 meeting the Council directed the SAC to evaluate three fixed ocean impact rate alternatives based on age-4 KRFC: ≤ 5%, ≤ 10% and ≤ 13%. The harvest impact rate alternatives have implementation thresholds of about 40,000, 47,000 and 52,000 adult natural spawners in the absence of fishing, respectively (Figure 2-1). Because these alternatives are impact rate caps, the Council would have the option of managing to a lower impact rate in any particular year, thus the 5% Cap and 10% Cap Alternatives would be available within the 13% Cap Alternative. The ocean impact rate approach takes into account landed and non-landed catch mortalities. The non-landed catch mortalities include drop offs and undersize Chinook salmon (shaker) mortalities. Use of an ocean impact rate standard would allow for consistent application of *de minimis* fishery impacts on KRFC. It is important to note that *the fixed ocean impact rate alternatives are not proposed to replace the 35,000 natural adult spawner floor, which would continue as a trigger for Overfishing Concerns.*

The 5% Ocean Impact Rate Cap Alternative (5% Cap Alternative) has a *de minimis* fishery threshold of about 40,000 naturally spawning adults (based on an assumed 12% SRR); that is, ocean fisheries would be allowed up to a 5% ocean impact rate on age-4 KRFC when the unfished population of naturally spawning fish was projected to be less than about 40,000 adult fish. The 5% Cap Alternative limits Council area ocean fishery impacts to a level similar to that identified in the FMP at Section 3.2.4.2 for stocks that are exploitation rate exceptions to the Overfishing Criteria. Those stocks are largely not available to harvest in Council fisheries because of migration timing and/or distribution. They are identified by a cumulative adult equivalent (AEQ) exploitation rate of less than 5% in base period ocean fisheries under Council jurisdiction in the appropriate fishery regulation assessment model (which, for Chinook salmon, is 1979-1982). The 5% standard was developed for stocks that are primarily harvested in the Pacific Salmon Treaty Area and that generally are outside the purview of the Council decision process.

The 10% Ocean Impact Rate Cap Alternative (10% Cap Alternative) represents an intermediate point between the 5% and 13% Cap Alternatives, which provides additional resolution to the analysis. The 10% Cap has a *de minimis* fishery threshold of about 47,000 unfished naturally spawning adults.

The 13% Ocean Impact Rate Cap Alternative (13% Cap Alternative) for age-4 KRFC has a *de minimis* fishery threshold of about 52,000 unfished naturally spawning adults. The 13% Cap Alternative would be more conservative (more restrictive to ocean fisheries) than the current ESA consultation standard for CCC salmon, which is a listed stock under the ESA. However, unlike KRFC, CCC salmon are not subject to significant freshwater harvest impacts. The 13% Cap Alternative approximates the rate KRFC were managed for in 2006 ocean fisheries, and represents an upper bound for impacts considered in this amendment.

Specified ocean impact rates are associated with additional river recreational and tribal fisheries that are set by allocation rules or assumptions (e.g., 50/50 catch sharing between tribal and non-tribal fisheries and 15% of non-tribal catch allocated to the river sport fishery). Each of the *de minimis* fishing alternatives is associated with an overall Spawner Reduction Rate (SRR). Details related to fishery metrics are discussed in Section 4. The SRRs associated with the 5%, 10% and 13% Cap Alternatives are about 12.5%, 25%, and 32.5%, respectively (Figure 2.1). The threshold levels for implementing the alternatives are approximate abundance levels, and would have to be determined precisely during the preseason planning process. The variation in age composition of KRFC returns and minimum size limits in fisheries result in different impacts of a given fishing strategy on the stock between years. The STT would be responsible for determining the reporting implementation threshold for a *de minimis* fishing strategy on an annual basis.

2.2 Alternative Eliminated from Detailed Study

Section 1.4.4, Scoping Summary, describes the alternatives considered by the Council, but not included in the final analysis. Consistent with 40 CFR 1502.14(a), the alternatives eliminated from detailed study were:

1. Use of an exploitation matrix with consideration for stock status of co-mingled Chinook salmon stocks and technical uncertainty,
2. A sliding scale alternative allowing increasingly lower total ocean and river fishery impacts (catch + incidental mortality) as stock abundance decreases,
3. A 16% fixed Cap Alternative based on age-4 ocean impact rate,
4. A rebuilding feature that would limit *de minimis* fisheries to no more than three consecutive years, with a minimum of three consecutive years with escapement above the 35,000 natural spawner floor before additional *de minimis* fisheries could occur, and
5. The prohibition of any fall/winter fisheries (September 1 through March 15) when *de minimis* fisheries take place.

The rationale for eliminating these alternatives was explained in Section 1.4.4.

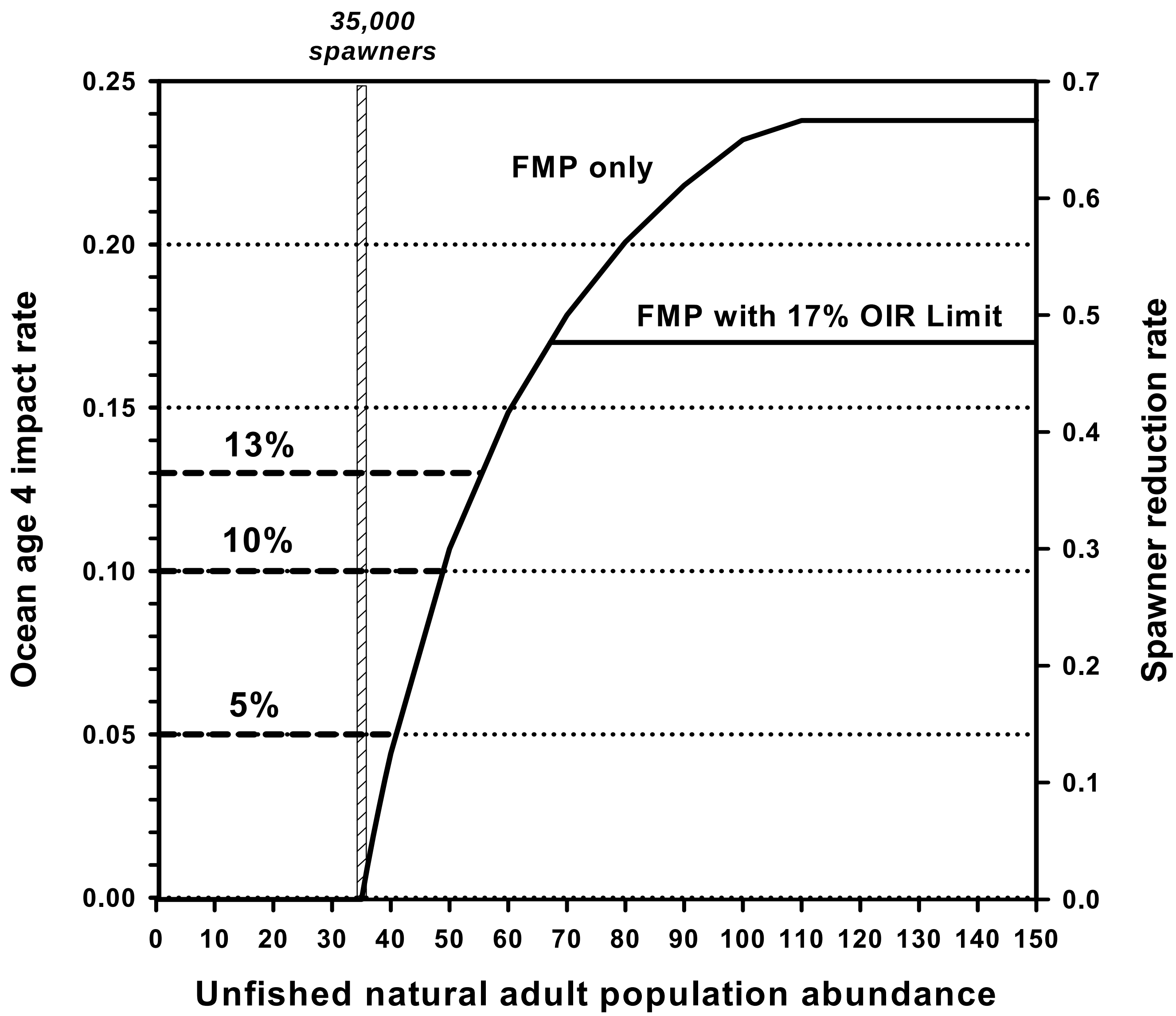

Figure 2-1. Implementation thresholds for *de minimis* fishing alternatives relative to FMP management and CCC standard (Status Quo Alternative).

3.0 AFFECTED ENVIRONMENT

The following descriptions summarize information provided in the FMP, preseason reports, and the 2006 Regulations EA.

3.1 Salmon FMU Stocks

Salmon are anadromous, living in the ocean, but returning to freshwater to spawn, and semelparous, dying after they spawn. Eggs are laid in nests (called redds) in stream bottoms with fairly specific characteristics, including clear, cool water and suitable gravel for redd excavation. After an incubation period that varies depending on water temperature, the eggs hatch into yolk sac larvae, which remain in the gravel until their sacs have been absorbed. The fry emerge, and after maturing into smolts capable of living in salt water, migrate downstream. These smolts may pause in lakes or estuaries before entering the ocean environment. Adults then spend from one to four years in the ocean before returning to spawn. Salmon return predominantly to their natal streams to spawn. Several stocks may return to freshwater during a given season; this constitutes a seasonal run. Therefore, management measures aim to constrain fishery impacts on distinct stocks or runs to levels appropriate for their status, as determined by the difference between projections of abundance and conservation needs.

Individual stocks exhibit considerable variability within these life history parameters: pre-spawning adult and post-hatchlings can spend varying amounts of time in freshwater, fish can mature at different ages, and ocean migration patterns can differ. In addition to natural characteristics, the development of hatchery rearing programs over the past century has added another dimension to management. Council-managed ocean fisheries catch mostly Chinook and coho salmon, and, to a lesser extent, pink salmon in odd-numbered years.

Population sustainability is predicated on the return of a sufficient number of adult fish, referred to as escapement, and their ability to successfully spawn. (Hatchery programs have the goal of increasing survival of juvenile fish by raising them under artificial conditions where mortality is comparatively low.) Management focuses on ensuring sufficient escapement for particular stocks and must also consider the timing of the seasonal runs in setting fishing seasons. Escapement levels can be assessed by monitoring the number of fish that reach freshwater spawning areas. Alternatively, managers may use allowable fishery exploitation rates instead of, or in addition to, escapement measures. Exploitation rates are commonly used to allow some fishing opportunity that might otherwise be precluded if management goals were based exclusively on escapement levels for depressed stocks. The abundance of hatchery-raised salmon, which in comparison to wild stocks are a less important reservoir of genetic variability,[5] has prompted management measures that direct fishermen to target and retain marked hatchery stocks in preference to wild fish.

Chinook salmon have specific life history features, showing considerable variation among stocks. In addition to age of maturity and timing of entry to freshwater, stream-type and ocean-type races have been identified. Stream-type fish spend one to two years in freshwater as juveniles before moving to the ocean. Adults enter freshwater in spring and summer, and spawn upriver in late summer or early fall. Juvenile ocean-type fish spend a few days to several months in freshwater, but may spend a long time in estuarine areas. KRFC are ocean type Chinook salmon and juveniles out migrate during spring-fall of their first year. Chinook salmon mature and return to spawn between two to six years of age, although most

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[5] Because the parent stock is fairly small, genetic diversity of these populations is lower. A related issue arises when hatchery-raised fish, returning to spawn as adults, interbreed with wild stocks, affecting wild population fitness.

returning fish are three to five years old. Precocious males that return to spawn early, at age two, are called "jacks." (Additional information about Council-managed salmon species' life histories may be found in EFH Appendix A, which describes salmon EFH.)

Salmon FMP Table 3-1 (an updated version is in Table A-1 in Appendix A of *Preseason Report I*) summarizes the individual West Coast stocks (or runs) identified for the purpose of managing ocean fisheries. This table describes salmon conservation objectives for each stock or run. Chinook salmon stocks are grouped into six major geographic categories, coho salmon into three, and pink into two. For reference, Chinook and coho salmon geographic categories and component stocks (both hatchery and wild) are listed in Table 3-1 of the FMP. It shows that nine Chinook and three coho salmon stocks are listed as either threatened or endangered under the Federal ESA. Lower Columbia River natural coho salmon were also listed as threatened under the Federal ESA in June 2005, and are a driving constraint in fisheries north of Humbug Mountain, Oregon.

Because salmon are anadromous, it is relatively easy to monitor the number fish that return to spawn (inriver escapement) and determine whether conservation objectives have been achieved. However, managers also need to predict ocean abundance and ocean escapement (number of fish reaching freshwater and available for inriver fisheries and escapement to spawning grounds). Although predictions cannot be made for all of the stocks listed in the FMP, estimates are made for the major stock components of the fishery, including KRFC. The components of the harvest for which abundance predictions are made are sufficient to allow reasonable projections of harvest or impact rate. The recent trend in under-predicting age-4 ocean harvest rate was addressed in 2006 with a change in input parameters to the KOHM that should correct the observed bias.

3.2 Salmon Stocks Listed Under the Endangered Species Act

ESA-listed species are managed under regulations pursuant to that law in addition to the MFCMA. "Take" (a term that covers a broader range of impacts than just mortality) of listed species may be allowed as long as it is not the primary purpose of the activity. (Therefore, catches of ESA-listed stocks are termed incidental take.) For salmon fisheries, this means incidental mortality may be allowed (including, for example, fish that are released or "drop off" the hook and consequently die). As part of the process authorizing such take, regulatory agencies must consult with NMFS[6] in order to ensure fisheries conducted in the Council area do not "jeopardize the continued existence of the species" (or in the case of salmon, the listed ESUs). Because of the Council's central role in developing fishery management regimes, it must take the results of such consultations into account. Typically this process, termed a "Section 7 consultation" after the relevant section in the ESA, results in a BO that applies a set of consultation standards to the subject activity and mandates those actions that must be taken in order to avoid such jeopardy. As listings have occurred, NMFS has initiated formal Section 7 consultations and issued BOs, which consider the impacts to listed salmonid species resulting from proposed implementation of the FMP (long-term opinions), or in some cases, from proposed implementation of the annual management measures. The consultation standards, which are quantitative targets that must be met to avoid jeopardy, are also incorporated into the Salmon FMP and play an important part in developing annual management measures. A Section 7 consultation may be reinitiated periodically as environmental conditions change, and new measures may be required to avoid jeopardy. (BOs for Council-managed salmon stocks were listed in Section 5.3.2 and are available from the NMFS Northwest Region office (http://www.nwr.noaa.gov). These documents also provide detailed information on the biology and status of these stocks.)

[6] NMFS is the designated agency for listed West Coast anadromous and marine species. The U.S. Fish and Wildlife Service is responsible for listed terrestrial species.

In addition to the Section 7 consultation, actions that fall under the jurisdiction of the ESA may also be permitted through ESA Section 10 and ESA Section 4(d). Section 10 generally covers scientific, research, and propagation activities that may affect ESA-listed species. Section 4(d) covers the activities of state and local governments and private citizens.

Section 4(d) of the ESA requires NMFS and the U.S. Fish and Wildlife Service to promulgate "protective regulations" for threatened species (Section 4(d) is not applicable to species listed as endangered) whenever it is deemed "necessary and advisable to provide for the conservation of such species."

> "Whenever any species is listed as a threatened species pursuant to subsection (c) of this section, the Secretary shall issue such regulations as he deems necessary and advisable to provide for the conservation of such species. The Secretary may by regulation prohibit with respect to any threatened species any act prohibited under section 9(a)(1) of this title ..."

These protective rules for threatened species may apply to any or all of the ESA Section 9 protections that automatically prohibit take of species listed as endangered. The rules need not prohibit all take. There may be an "exception" from the prohibitions on take, so long as the take occurs as the result of a program that adequately protects the listed species and its habitat. In other words, the 4(d) rule can restrict the situations to which the take prohibitions apply.

Sec 9(a)(1) includes the take prohibition. The U.S. Fish and Wildlife Service adopted a blanket regulation automatically applying the take prohibition to all threatened species upon listing. NMFS has no comparable blanket 4(d) regulation. Instead, NMFS promulgates 4(d) regulations on a species-by-species basis once a species is listed as threatened.

In proposing and finalizing a 4(d) rule, NMFS may establish exemptions to the take prohibition for specified categories of activities that NMFS finds contribute to conserving listed salmonids. Other exemptions cover habitat-degrading activities (and tribal and recreational fishing activities) that NMFS believes are governed by a program that adequately limits impacts on listed salmonids.

As part of the process for developing annual management measures, NMFS summarizes the current consultation standards and may provide additional guidance to the Council on minimizing the take of listed species. Appendix A in *Preseason Report III* summarizes this guidance.

The CCC salmon ESU was listed as threatened in April 2000. The ESU includes populations south of the Klamath River and north of San Francisco Bay. Limited information on ocean distribution and fishery impacts is available for these populations, but they are believed to be similar to KRFC. As a result, NMFS used KRFC as a surrogate for CCC when it established ocean fishery consultation standards for CCC, and determined that an ocean harvest rate of no more than 16.0% on age-4 KRFC was not likely to jeopardize the continued existence of the ESU.

3.3 Socioeconomic Environment

Chapter IV in the *Review of 2005 Ocean Salmon Fisheries* (STT 2006a) provides information on the socioeconomic environment. More extensive information on ocean and inside salmon fisheries is provided in Appendix B to the Salmon FMP. Information on fishing communities is provided in Appendices A and B to the Council's description of West Coast fishing communities.

The most significant trend in the non-Indian commercial troll fishery is the steep decline in the real ex-vessel value of landings from the 1980s to the 1990s; there was a modest increase over the past few years (see Figure IV-4 in the *Review*). These trends reflect both declining landings and the real ex-vessel price for coho and Chinook during that period; prices did increase sharply in the past few years, contributing to overall revenue increase (see Figure IV-3 in the *Review*). Coastwide, the number of participating commercial vessels has declined and in 2005 was 6% less than in 2004. In California participation decreased by 9% compared to 2004, and 72% compared to the 1986-1990 average; in Oregon participation decreased by 5% compared to 2004, and was 72% below the 1986-1990 average; in Washington participation increased by 6% compared to 2004, but was 90% below compared to the 1986-1990 average.

Recreational fishing for ocean salmon includes private vessels, charter boats, and some shore-based fishing, although this last component accounts for a small amount of the recreational ocean catch. In 2005, California exhibited the highest proportion of charter boat participation of the three states and the highest overall level of recreational effort, with a combined 171,900 estimated trips, of which 40 percent were on charter boats. This reflects a general recovery in recreational participation since 2003, although down from 2004. Effort in Oregon and Washington fell substantially in 2005 from the levels seen in 2003 and 2004, although it was still higher than typical values in the 1990s (Figure 3-6). Over the long term there has been a decline in the number of ocean recreational trips, with most of the decline occurring from the Eureka area north. In recent years, ocean recreational trips have been supported in Washington and Oregon by the implementation of mark-selective fisheries for coho with healed adipose fin clips.

While analysis of impacts to the natural environment is organized around stocks that spawn in particular rivers, the social dimension, including management measures, is organized around ocean management areas, as described in the Salmon FMP. These areas also correspond to some extent with the ocean distribution of salmon stocks, although stocks are mixed in offshore waters. Broadly, from north to south these areas are (1) from the U.S./Canada border to Cape Falcon (45°46' N. lat.), which is on the Oregon coast south of the Columbia River mouth; (2) between Cape Falcon and Humbug Mountain (42°40' 30" N. lat.) on Oregon's southern coast; (3) the Klamath Management Zone, which covers ocean waters from Humbug Mountain in southern Oregon to Horse Mountain (40°05' N. lat.) in northern California; and (4) from Horse Mountain to the U.S./Mexican border. (There are also numerous subdivisions within these areas used to further balance stock conservation and harvest allocation considerations.) Figure 3-3 shows the boundaries of these areas and the main salmon ports. The following description of the fisheries and fishing communities is organized around these areas and is derived from the *Review*. For the purpose of characterizing the economic impact of Council area salmon fisheries, coastal community level personal income impacts were used (Figures 3-7a and 3-7b).

As salmon seasons become more restrictive, the potential for effort transfer into other fisheries increases, particularly for commercial groundfish, albacore, and crab fisheries, and recreational groundfish, halibut, and inside fisheries. Commercial and recreational charter businesses will seek other opportunities to generate income by participating in other fisheries, which could accelerate quota attainment and increase competition. Private recreational fishermen will also seek alternate fishing activities with similar results.

3.3.1 Cape Falcon to Humbug Mountain (Central Oregon Coast)

Stocks on Which the Fisheries Rely

Fisheries in this area catch a mix of stocks, which varies from year to year in response to the status of individual stocks. Oregon Coast Chinook, Central Valley, and KRFC stocks contribute substantially to these fisheries. Although regulations have prohibited retention of coho in commercial fisheries south of Cape Falcon since 1993, limited recreational fishing that is selective for marked coho has been permitted since 1999. Washington coastal, Columbia River, and Oregon coastal coho stocks are encountered in this area.

Commercial Fisheries

Oregon coast ports between Cape Falcon and the KMZ are the major contributors to Chinook landings, along with California ports south of the KMZ; in 2005, the Cape Falcon to Humbug Mountain harvest accounted for 36% of all commercial Chinook landings from the Council area. Coho landings were very large between Cape Falcon and Humbug Mountain until 1992 when, as noted, stock declines coupled with regulatory actions eliminated most landings south of Cape Falcon. (Some mortality to coho stocks still occurs in conjunction with effort targeted on Chinook. Mortality from gear encounters, including drop-off and hook-and-release, is accounted for in coho mortality estimates.) Tillamook, Newport, and Coos Bay are the major port areas in this zone; almost half of the Chinook landings were made at Newport.

Recreational Fisheries

Central Oregon recreational coho landings accounted for about 6% of Council-area-wide recreational coho catch and 8% of the total recreational salmon catch in 2005. Seasonal management measures allowed a selective fishery for marked coho in this area. This area accounted for 15% of Council-area-wide recreational fishing trips in 2005; 85% were on private boats. Of the three ports in this area, Newport originated the most charter trips in 2005. But the two other ports (Tillamook and Coos Bay) each originated more private trips than the number of charter trips or private trips out of Newport. Thus, while Newport is an important center for charter fishing, recreational fishing on private boats is important at all of the ports in the area.

3.3.2 Humbug Mountain to Horse Mountain (KMZ)

The KMZ covers waters in southern Oregon and northern California around the mouth of the Klamath River. This is geographically the smallest zone. A significant component of the allocation issues in this zone are the harvest needs of Klamath River tribal and sport fisheries.

Stocks on Which the Fisheries Rely

The KMZ was created to focus management on KRFC because the impacts of ocean fisheries have predominantly occurred in this area. Other major contributors to the harvest in this area include the Sacramento Valley and southern Oregon coast Chinook stocks. Retention of coho is prohibited in California (NMFS ESA consultation standard for southern Oregon/northern California coastal [SONCC] and central California coastal [CCC] coho ESUs (NMFS 1999).

Commercial Fishery

This area accounts for a small proportion of commercial landings. In 2005, only about 1% of Council-area-wide commercial Chinook landings were made at the three major ports in this zone: Brookings, Oregon; and Crescent City and Eureka in California.

Recreational Fishery

This area accounts for a small portion of recreational landings, about 11% of coast wide Chinook landings. About 9% of Council-area-wide angler trips occurred in the KMZ in 2005, with 96% of these trips made on private vessels. Charter fishing in the zone, from a Council- area-wide perspective, accounted for less than half a percent in 2005.

3.3.3 South of Horse Mountain

Although this area is defined as stretching to the U.S./Mexican border, ocean salmon fishing generally occurs only as far south as Point Conception, California

Stocks on Which the Fisheries Rely

Central Valley Chinook stocks are important throughout this area, particularly south of Fort Bragg (Point Arena). Southern Oregon Chinook stocks contribute to fisheries in the northern portion of this area. KRFC and Sacramento River winter run Chinook stocks are also caught in this area, and the conservation needs for these stocks often have a significant effect on ocean harvest management measures. Coho retention is prohibited in California (NMFS ESA consultation standard for SONCC and CCC coho ESUs, NMFS 1999).

Commercial Fisheries

California commercial fisheries historically have been the major component of Council-area-wide ocean salmon fishing, consistently accounting for a major share of Chinook landings; 50% in 2005, and as much as 75% as recently as 2000. Coho were less important historically than Chinook; coho retention in commercial fisheries south of Cape Falcon has not been allowed since 1993 to reduce impacts on OCN and other depressed coho stocks.

Major ports in this area (as listed in *Review* Table IV-6) are Fort Bragg, San Francisco, and Monterey. In recent years San Francisco has been the major port for commercial landings, accounting for about two-thirds of landings at the three ports and half of landings in this area in 2005. Opportunity in Fort Bragg was reduced beginning in 1990 to reduce impacts on KRFC. Monterey and Fort Bragg had a greater share of landings in the past, and as recently as 1996, Monterey landings exceeded San Francisco's.

Recreational Fisheries

This area had the largest share of Council-area-wide recreational Chinook landings in 2005 at 46%; coho landings were negligible, reflecting regulations prohibiting coho retention. (The reported landings include some illegal harvest, as footnoted in the Review tables.) The number of recreational trips has remained more stable over the long term in the area south of Horse Mountain than in areas to the north where effort declined substantially in the 1990s. As a result, the number of trips occurring in this area as a proportion of coast wide trips has generally increased and accounted for the largest share of angler trips in Council-area recreational salmon fisheries. Charter fishing historically, and today, has accounted for a much larger fraction of recreational trips in this area, as compared to areas to the north; in 2005, 43% of trips south of Horse Mountain were made by charter vessels. San Francisco is by far the largest port for charter trips, while private recreational trips are more evenly distributed among the three ports in this area.

3.3.4 Catch, Effort and Economic Impact Data for Oregon and California Ocean Salmon Fisheries South of Cape Falcon

Catch and effort data for 2000-2004 were used to describe and compare the Oregon and California ocean salmon fisheries south of Cape Falcon (Table 3-1). In these years, the Oregon troll fishery averaged 11,600 boat days and 253,000 Chinook salmon per year. Most of the effort and catch was in the Tillamook-Newport area (Northern Oregon). The California troll fishery averaged 17,900 boat days and 411,800 Chinook salmon per year. Most (55%) of the California fish were landed in the San Francisco area. The low effort and catch in the KMZ troll fishery was the result of regulations aimed at reducing fishery impacts on KRFC, which are in high abundance in the area.

The Oregon sport fishery averaged 101,600 angler-days and 37,200 Chinook salmon per year during 2001-2005 (Table 3-1). The California fishery averaged 180,100 angler days and 148,000 Chinook salmon per year. San Francisco averaged 46% of the recreational effort and 52% of the California recreational Chinook salmon catch. The KMZ sport fisheries (KO and KC) landed more Chinook salmon than the KMZ troll fishery (22,600 compared to 17,600). The combined troll fisheries in the other areas took 80% of the total Chinook salmon catch. The shift of troll catch out of the KMZ shows the effect of regulations aimed at reducing troll fishery impacts on KRFC while attempting to maintain a viable KMZ ocean salmon recreational fishery.

Economic impact estimate averages for 2001-2005 show that about half (52%) of the Oregon impact estimate of $20.0 million occurred in the Northern Oregon area (Table 3-2). It is important to note that some of the recreational fishery impact was associated with mark selective hatchery coho salmon fishing. The California ocean salmon fisheries which were entirely based on Chinook salmon were valued at about $44 million annually with about half (58%) of the impact in San Francisco-area fisheries.

Table 3-1. Average annual Oregon and California ocean Chinook salmon fishing effort and catch by fishery and KOHM port area during 2001-2005.

State	Area[a/]	Effort	Catch
Commercial Troll (boat days)			
Oregon	NO	6,251	151,595
South of Cape Falcon	CO	4,934	117,519
	KO	439	5,245
	Total	11,624	274,359
California	KC	381	12,430
	FB	3,258	96,438
	SF	8,823	210,097
	MO	4,665	64,879
	Total	17,127	383,844
Sport (angler days)			
Oregon	NO	48,788	15,022
South of Cape Falcon	CO	34,491	15,190
	KO	18,291	7,027
	Total	101,571	37,238
California	KC	20,947	15,559
	FB	28,175	23,706
	SF	83,482	77,207
	MO	47,488	31,501
	Total	180,092	147,973

a/ NO=Northern Oregon (Tillamook/Newport); CO=Central Oregon (Coos Bay); KO=Oregon KMZ (Brookings); KC=California KMZ (Crescent City/Eureka); FB=Fort Bragg; SF = San Francisco; MO=Monterey.

TABLE 3-2. Estimates of average annual coastal community and state personal income impacts for Oregon and California troll and recreational ocean salmon fisheries by port area in 2005 dollars (000s) during 2001-2005.[a/]

	Area[b/]					
		NO	CO	KO	Community Total	State
Oregon						
Troll		$5,741.4	$4,367.1	$836.2	$10,944.7	$12,705.1
Recreational		$2,823.7	$1,815.3	$805.1	$5,444.1	$7,274.3
Totals		$8,565.1	$6,182.4	$1,641.3	$16,388.8	$19,979.4
California	KC	FB	SF	MO	Community Total	State
Troll	$730.2	$5,225.4	$13,556.2	$4,008.0	$23,519.9	$24,854.0
Recreational	$1,193.2	$2,133.2	$9,551.1	$3,529.2	$16,406.7	$19,152.8
Totals	$1,923.4	$7,358.7	$23,107.3	$7,537.2	$39,926.6	$44,006.8

a/ Per pound and per day estimates of income impacts provided by the Fishery Economic Assessment Model (FEAM). These are the income impacts associated with expenditures in the troll or recreational sectors. There is no differentiation between money new to the area and money which would otherwise have been expended in other sectors. It is assumed that all fish landed at a port is processed in the port area. Values are based on a 1998 run of the FEAM using 1996 U.S. Forest Service IMPLAN data.

b/ NO=Northern Oregon (Tillamook/Newport); CO=Central Oregon (Coos Bay); KO=Oregon KMZ (Brookings); KC=California KMZ (Crescent City/Eureka); FB=Fort Bragg; SF = San Francisco; MO=Monterey.

3.3.5 Fall/Winter Chinook Salmon Fisheries

The KOHM uses fishery impact data from previous fall (September-December) ocean fisheries to evaluate summer fishing regulations in the context of harvest sharing and biological goals. Fall fisheries impact primarily age-4 and age-5 KRFC, which are the immature members of the age-3 and age-4 cohorts, respectively, that entered the river prior to September 1 of the same year. The KOHM does not project ocean impacts of fall fisheries on following year harvest sharing and biological goals, including the possible need for *de minimis* fishing regulations. This report section has been prepared to show the relative importance of fall/winter fisheries to the respective states and ports.

Catch and effort data for 2001-2005 were used to measure the importance of fall Chinook salmon fisheries off Oregon south of Cape Falcon and California (Table 3-3). Fall Chinook salmon fisheries were on average more active in Oregon than in California during these years. Fall/winter troll effort and Chinook salmon catch averaged 28% and 31%, respectively, of total average annual effort and catch for the Oregon troll fishery. Comparable figures for California were 17% of the average annual troll effort and 13% of the annual troll Chinook salmon catch. Recreational fishing effort and catch proportions in fall/winter fisheries in Oregon were 13% and 20%, respectively, of annual averages. Comparable figures for the California recreational fishery were 10% of average annual effort and 8% of average annual Chinook salmon catch. Fall/winter fisheries were particularly important to KMZ troll fisheries, representing 46% and 81% of annual effort averages and 34% and 52% of annual catch averages in the Brookings (KO) and Crescent City-Eureka (KC) areas, respectively.

Table 3-3. Proportion of average annual Oregon and California ocean Chinook salmon fishing effort and catch by fishery and KOHM port area during fall months (September-December), 2001-2005.

		Effort					Catch				
State	Area[a/]	Sept	Oct	Nov	Dec	Total	Sept	Oct	Nov	Dec	Total
Commercial Troll (boat days)											
Oregon	NO	0.17	0.12	0.00		0.29	0.20	0.16	0.00		0.36
South of Cape Falcon	CO	0.13	0.09	0.03	0.01	0.25	0.16	0.07	0.01	0.00	0.25
	KO	0.19	0.25	0.02		0.46	0.23	0.10	0.01		0.34
	Total	0.15	0.11	0.01	0.00	0.28	0.18	0.12	0.00	0.00	0.31
California	KC	0.80	0.01			0.81	0.51	0.01			0.52
	FB	0.32				0.32	0.28	0.00			0.28
	SF	0.14	0.03			0.17	0.06	0.01			0.07
	MO	0.03				0.03	0.01	0.00			0.01
	Total	0.16	0.02			0.17	0.12	0.01			0.13
Sport (angler days)											
Oregon	NO	0.13	0.07	0.00		0.20	0.17	0.09	0.00		0.26
South of Cape Falcon	CO	0.07	0.00			0.08	0.10	0.00			0.10
	KO	0.14	0.16			0.30	0.21	0.07			0.28
	Total	0.06	0.06	0.00		0.13	0.15	0.05	0.00		0.20
California	KC	0.10				0.10	0.12				0.12
	FB	0.04	0.00	0.00		0.04	0.02	0.00	0.00		0.02
	SF	0.11	0.05	0.01		0.17	0.08	0.03	0.01		0.11
	MO	0.01				0.01	0.00				0.00
	Total	0.07	0.02	0.01		0.10	0.06	0.02	0.00		0.08

a/ NO=Northern Oregon (Tillamook/Newport); CO=Central Oregon (Coos Bay); KO=Oregon KMZ (Brookings); KC=California KMZ (Crescent City/Eureka); FB=Fort Bragg; SF = San Francisco; MO=Monterey.

3.3.6 Klamath River Fisheries

Data on Klamath River Chinook salmon harvest in river tribal and non-tribal recreational fisheries are available at: http://www.pcouncil.org/salmon/salbluebook/salbluebook.html.

Tribal Fisheries

During 2001-2005, the tribes harvested an average of 37,500 Chinook salmon, including 11,900 (32%) spring run and 25,600 (68%) fall run. Most of the fish (82% spring run and 63% fall run) were used for subsistence purposes and remainder for commercial purposes. Most of the tribal fish (66%) were harvested in the estuary (Table 3-4). A recent report by the Yurok tribe indicated the average value of a commercial caught KRFC is worth about $45 per fish to the tribal fisherman (Yurok Tribe 2006).

Table 3-4. Average annual Yurok and Hoopa Valley tribal fishery harvest of spring and fall-run Chinook salmon by fishery and area, 2001-2005.

	Spring-run	Fall-run	Totals
Commercial			
Estuary	1,554	9,478	11,032
Upper Klamath	797	152	949
Commercal fishery total:	2,351	9,630	11,981
Subsistence			
Estuary	4,000	9,614	13,615
Middle Klamath	1,348	981	2,329
Upper Klamath	1,688	2,737	4,425
Trinity River	2,705	2,632	5,337
Subsistence fishery total	9,741	15,964	25,705
Total All Fisheries	12,092	25,594	37,686

Klamath River Recreational Fishery

River recreational fishermen harvested an annual average of 7,600 adult KRFC during 2001-2005. The CDFG does not make annual angler effort estimates for Klamath River basin salmon and steelhead fisheries. Lower river (below Coon Creek, river mile 35) sampling during 2001-2005 showed an average adult Chinook salmon catch of 6,100 adults in 18,300 angler trips (86,100 hours) for boat and shore anglers combined (CDFG file data). The amount of effort directed at salmon, steelhead or a combination of species was not differentiated in the sampling.

4.0 ANALYSIS OF ALTERNATIVES

The factors evaluated for significance in this EA are those listed in Section 6.02 of NAO 216-6, with specific application to these alternatives as detailed in Section 1.56 of this EA. Some of those factors have already been eliminated from further consideration in this analysis through the screening process applied in Section 1.5, including non-target species, EFH, biodiversity and ecosystem function, and public health and safety. Criteria for evaluating significance of the remaining factors are described in Section 1.5.

The approach used to analyze and measure differences in the Council's alternatives was as follows: 1) a Hindcast Analysis of the alternatives was conducted using historical ocean stock size and fishery impact information, 2) an age-structured stochastic stock recruitment modeling (SSRM) was used to forecast the probabilities of meeting the evaluation criteria described in Section 1.5, and 3) economic modeling was done to compare the alternatives as they relate to community impacts. All three approaches have limitations that are discussed in the respective sections.

A description is provided at the beginning of this section of the various ways to express fishery effects on KRFC, including computational methods. Certain of these metrics are used in the analysis of the Council's *de minimis* fishery alternatives.

4.1 Fishery Metrics

There are various ways of measuring and regulating fishery effects on target (and non-target) fish populations. One common unit of measure (metric) of fishery effect is harvest rate, which is the landed catch of fish expressed as a proportion of the standing population size. In salmon management, harvest rate is usually expressed in terms of number of fish removed per unit of time, such as a week, month or season. The age-4 ocean harvest rate on KRFC is the ESA consultation standard metric used for CCC salmon.

The Council directed the SAC to express fishery effects on KRFC under the *de minimis* fishing alternatives in terms of age-4 ocean fishery impact rates. Fishery impacts include landed catch and non-retention fishery-related mortalities. Non-retention mortalities include drop-off and hook-and-release salmon mortalities. Fishery impact rates thus represent a more comprehensive approach to expressing fishery effects on KRFC than harvest rate. However, other metrics important to the management of the stock include adult equivalent (AEQ) impact and SRR.

A comparison of recent measures of forecast fishery effects on KRFC used data that were taken from final pre-season model runs of the KOHM, which were available for the 2002-2006 seasons. The 2002 season was the first year that estimates were available showing the effect of minimum size limits on fishery discards (shakers) and open fishing days on troll and recreation fishing effort. These data were required to calibrate the tools that were developed for this initiative. The KOHM is updated every year so annual model outputs represent the best available information on projected impacts of ocean and river fisheries on KRFC. The comparisons show the varied impact of ocean fisheries on the size and age composition of terminal run sizes and river harvests of KRFC. The important factors include initial ocean stock size and age composition, adopted management measures, timing of the catch, and allocations to river sport and tribal fisheries. KOHM inputs and outputs were used for making these calculations, except that an additional output was needed showing AEQ impact rates, which are required to calculate SRRs. A spreadsheet model was developed to make these calculations using KOHM input variables.

Table 4-1 shows an array of fishery effect metrics for KRFC for the 2002-2006 seasons, including a description of each metric and the annual relationship of age-4 ocean harvest rate and age-4 ocean impact rate. As can be seen, the relationships between these metrics were highly variable between years. Table 4-2 shows important management information, adopted minimum size limits (MSLs) river sport fishery allocations, and information on the catch of KRFC during Sept-Nov. ("fall") fisheries. All of these variables affected the metrics shown in Table 4-1.

The relatively high SRRs during 2002-2004 stem from high abundance of age-4 fish (Figure 1-1). The relatively high projected SRR in 2006 stems from the reduced spawner goal for that year of 21,100 natural spawners. The high river fishery SRRs in 2002 and 2003 are partly a result of increased allocation of fish to the river sport fishery (stemming from ESA constraints on ocean fishing in those years). Relatively high abundance of age-3 fish in 2005 did not allow for robust ocean or river fishing due to low age-3 maturation rate (37.8%) and relatively low natural survival rate of age-3 KRFC (58.5%).

As shown in Table 4-1, the ocean impact rate for KRFC increased during 2002-2006 compared to the ocean harvest rate. This reflects increased non-catch mortality, mostly in the troll fishery associated with increased minimum size limits from 26 inches total length (TL) in 2002 to 27 and 28 TL inches in 2006, likely aimed at reducing catch of age-3 KRFC. The sport fishery minimum size limit increased during this same period, but had less impact because of overall lower catch compared to the troll fishery (Table 4-2) and because a high proportion of age-3 fish are over 24 inches TL during summer months when the sport fishery is most active. The age-4 harvest rate averaged 89.6% of the age-4 impact rate over all years. The increase in fall catches shown in Table 4-2 almost entirely affected age-4 and age-5 fish. These catches were confusing because they include such a high proportion of the total annual catch of these two age groups, age-5 in particular. Since nearly all of these catches occurred in September (after the start of the biological year for KRFC), it is possible that a higher than expected proportion of these fish were actually destined to spawn in the same year they were harvested; i.e., they were late in entering the river, and were actually age-3 and age-4 fish when they were harvested. These late season catches need further analysis, but such a study is beyond the scope of this initiative. For all these years the tribal allocation was 50% of the total allowable catch based on KOHM preseason projections.

Table 4-1. Comparison of fishery affect metrics for 2002-2006 seasons based on KOHM pre-season projections.

Age	Abbreviation[a/]	Description	2002	2003	2004	2005	2006
4	O.HR	Age 4: ocean catch ÷ initial age 4 population size	0.13	0.16	0.15	0.08	0.12
4	O.IR	Age 4: ocean impact ÷ initial age 4 population size	0.14	0.17	0.16	0.09	0.14
4	O.SRR	Age 4: ocean adult equivalent impact ÷ (ocean adult equivalent impact + river run size)	0.16	0.20	0.19	0.10	0.15
3-5	O.HR	Age 3-5: ocean catch ÷ initial population size	0.08	0.10	0.12	0.03	0.09
3-5	O.IR	Age 3-5: ocean impact ÷ initial population size	0.09	0.11	0.14	0.03	0.11
3-5	O.SRR	Age 3-5: ocean adult equivalent impact ÷ (ocean adult equivalent impact + river run size)	0.14	0.17	0.19	0.06	0.15
3-5	R.SRR	Age 3-5: river impact ÷ river run size	0.57	0.50	0.40	0.14	0.24
3-5	T.SRR	Age 3-5: (ocean impact spawners + river impact) ÷ (ocean impact spawners + river run)	0.63	0.60	0.52	0.20	0.35
		Age 4 OHR ÷ Age 4 OIR	0.94	0.93	0.92	0.87	0.83
		Spawning Escapement Projection:	35,000	35,000	35,000	35,000	*21,100*

a/ O= Ocean; R= River; T= Total; HR= Harvest Rate; IR= Impact Rate; SRR= Spawner Reduction Rate. *Note:* the CCC salmon standard is based on age-4 ocean harvest rate (O.HR)

Table 4-2. Important fishery management decisions and fishery catch proportions, 2002-2006 KOHM projections.

	Fishery	Age	2002	2003	2004	2005	2006	Avg
Minimum Size Limits (summer):	Troll:		26	26/27	26/27	27/28	27/28	NA
Inches total length	Sport:		20	20	20	20/24	20/24	NA
Annual Catch Proportion by Fishery and Age	Troll	3	80.1%	67.2%	65.8%	38.4%	59.3%	62.2%
		4	86.3%	84.6%	65.8%	77.5%	83.5%	79.5%
		5	80.7%	64.4%	81.3%	88.4%	94.6%	81.9%
		Total	84.0%	79.2%	80.6%	63.3%	83.5%	78.1%
	Sport	3	19.9%	32.8%	34.2%	61.6%	40.7%	37.8%
		4	13.7%	15.4%	17.3%	22.5%	16.5%	17.1%
		5	19.3%	35.6%	18.7%	11.6%	5.4%	18.1%
		Total	16.0%	20.8%	19.4%	36.7%	16.5%	21.9%
Annual Catch Proportion in Fall by Fishery and Age	Troll	3	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
		4	10.3%	26.8%	27.2%	48.7%	60.5%	34.7%
		5	19.3%	20.0%	75.6%	68.8%	99.5%	56.6%
		Total	7.5%	20.6%	31.0%	39.7%	65.1%	32.8%
	Sport	3	0.0%	0.0%	0.0%	1.8%	0.0%	0.4%
		4	9.4%	7.6%	18.9%	19.6%	47.9%	20.7%
		5	46.7%	67.3%	75.7%	0.0%	98.0%	57.5%
		Total	7.7%	8.6%	22.2%	7.5%	40.9%	17.4%
	Total	3	0.0%	0.0%	0.0%	1.1%	0.0%	0.2%
		4	10.2%	23.9%	25.7%	42.2%	58.4%	32.1%
		5	24.6%	36.8%	75.6%	60.8%	99.5%	59.5%
		Total	7.5%	18.1%	29.3%	27.9%	61.1%	28.8%
River Sport Allocation:			40.6%	30.4%	15.0%	15.0%	0.0%	NA
Tribal Allocation:			50.0%	50.0%	50.0%	50.0%	50.0%	NA

4.1.1 Harvest Impact Conversions for De minimis Fishery Alternatives

The relationship between ocean harvest rate and ocean impact rate is affected by changes in management measures or fishery assumptions as they apply to non-landed salmon catches. In recent years these variables have remained fairly consistent except for fishery minimum size limits, which have increased in recent years (Table 4-2). This has resulted in increased shaker mortalities of KRFC, mostly in the troll fishery. In 2002 the projected ocean harvest rate for age-4 KRFC was 94% of ocean impact rate. It declined each year thereafter and was 83% of the projected age-4 ocean impact rate in 2006 (Table 4-1). Thus, there is not a simple conversion rate formula for ocean harvest rate-to-ocean impact rate. For example, the average conversion rate for 2002-2006 (impact rate = 0.896*harvest rate) would indicate the CCC salmon consultation standard of 16.0% approximates a 17.9% ocean impact rate. However, based on traditional fishery minimum size limits which were in place in 2002 the 16.0% standard approximates a 17.0% ocean impact rate (Table 4-1). It is important to note that the relationship between total SRR and age-4 ocean impact rate varies with age composition of the KRFC ocean population and management measures that select for size of fish.

The age composition data (Table 4-3) was analyzed by iteration to determine the ocean age-4 impact rate that would equal a SRR of 10%. The computed value was 38%, which was rounded to 40%. Age composition and fishery selectivity measures affected the relationships between ocean fishery metrics and SRR values, as explained above. Thus the 40% value for expressing the relationship between age-4 ocean impact rate and SRR was an approximation. Additional data relating age-4 ocean impact rate to SRR were presented in Section 4.2.2.

4. 2 Hindcast Analysis of 1985-2006 Stock Abundance and Fishery Information

Application of the *de minimis* fishery alternatives to past season's population data and recent years' estimation procedures in terms of meeting or deviating from current stock conservation objectives provided an historical perspective of frequency of implementation and fishery effect of the *de minimis* fishery alternatives.

4.2.1 Methods

The Hindcast Analysis calculates the frequency and impact of the respective *de minimis* fishing alternatives on 1985-2006 age composition projections (Table 4-3) using pre-season projections of harvest impacts. This represents all of the years for which age-specific pre- and post-season stock abundance projections have been made by the STT. The natural escapements for 1985-2001 are calculated using the basic procedure and stock parameter estimates used in setting annual escapement goals for the stock since 1985 (Table 4-3). In the Klamath Basin "natural" spawners refers to spawning location not to parental origin; i.e., hatchery origin fish spawning in a natural stream are counted as natural spawners. The actual pre-season forecasts were used to determine the natural spawner projections during 2002-2006. Post-season estimates of stock abundance and harvest impacts are not used because such information (perfect knowledge) would have lead to different management decisions during 1985-2006 and increased the probability of meeting natural escapement goals in those years. It is important to note that this analysis is "static" and does not project the effect of reduced spawning escapement on future production. Section 4.2.3 presents an analysis of the effect of *de minimis* fishing on following year ocean abundance levels (carry-over effect). Also, these are pre-season projections which, for the Status Quo Alternative, were not always in close agreement with post-season estimates of natural spawning escapement. . The pre-season projections were generally higher than the post-season estimates. The deviations in pre- and post-season estimates for KRFC are presented and analyzed in Section 4.3.1.

Age specific ocean population sizes and projected natural spawning escapements with no fishing are shown in Table 4-3.

The methods and formulas used to calculate SRR and natural escapement goals for the Status Quo and each of the *de minimis* fishery alternatives are documented in Appendix E. The Status Quo Alternative did not require supplemental data to make the calculations; the fixed cap alternatives required approximations of AEQ impacts which required analysis of past ocean fishery impact estimates.

A generalized version of the calculations follows:

*Status Quo natural spawner*s= higher of a) unfished natural stock run size * 0.333 or b) 35,000 natural spawners, where SRR = (unfished natural stock run size – natural spawner floor) ÷ unfished natural stock run size.

Fixed Cap natural spawners (determined separately for each alternative) = (1-SRR) * unfished natural stock size, where SRR (unique for each alternative) = (ocean AEQ impact + river sport impact + river tribal impact) ÷ (ocean AEQ impact + river run size).

The implementation decision in this analysis was based on: which of the alternatives would provide for the higher level of fishery harvest (higher SRR) in each year of the 22 year-series. It is important to note that under any of the fixed cap alternatives the allowable SRR and associated natural spawner projection must be calculated every year. This is because the allowable impact rate is affected by ocean fishery minimum size limits and age composition of ocean abundance estimates. Geographic distribution of the ocean harvest may also affect the allowable SRR and river sport fishery allocation.

Table 4-3. Ocean abundance and natural spawner projections for Hindcast Analysis, 1985-2006 (000s).

Season	Ocean Abundance				Natural spawners with no fishing
	Age 3	Age 4	Age 5	Total	
1985	113.0	56.9	0.0	169.9	38.4
1986	426.0	66.3	0.0	492.3	81.5
1987	511.8	206.1	5.3	723.2	154.8
1988	370.8	186.4	13.3	570.4	133.1
1989	450.6	215.5	10.1	676.2	153.8
1990	479.0	50.1	7.6	536.8	85.5
1991	176.2	44.6	1.5	222.3	41.9
1992	50.0	44.8	1.3	96.0	26.0
1993	294.4	39.1	1.1	334.6	54.1
1994	138.0	86.1	0.5	224.6	54.2
1995	269.0	47.0	2.0	318.0	54.8
1996	479.8	268.5	1.1	749.4	175.0
1997	224.6	53.9	7.9	286.4	55.4
1998	176.0	46.0	3.3	225.3	43.4
1999	84.8	78.8	2.0	165.6	45.3
2000	349.6	38.9	1.4	389.9	61.1
2001	187.2	247.0	1.3	435.5	129.3
2002	209.0	143.8	9.7	362.5	94.8
2003	171.3	132.4	6.5	310.2	87.1
2004	72.1	134.5	9.7	216.3	72.3
2005	185.7	48.9	5.2	239.8	43.7
2006	44.1	63.7	2.2	110.0	32.5

Bootstrap sampling was used to estimate probabilities of occurrence for two key evaluation criteria using hindcast data: 1) probability of a spawning escapement in any year below the 35,000 natural spawner floor (Conservation Alert Year, CAY), and 2) probability of three consecutive years of natural spawning escapement below the 35,000 floor (Overfishing Concern, OC) within a 40-year time period. Each sample consisted of 40 years of data drawn at random with replacement. This was done 100 times for each alternative. A generalized version of the calculations follows:

CAY probability = sum of bootstrap sample probabilities ÷ bootstrap sample size

OC probability = sum of OC bootstrap sample occurrences ÷ bootstrap sample size

There were multiple OC categories in the bootstrap samples so there were multiple categories of OC probabilities.

The use of random sampling underestimates the frequency of OCs for fishing strategies that substantially increase the frequency of CAYs. This is because stock depressions usually occur in successive years (Table 4-4). Thus the OC results should be viewed as underestimates of OC frequencies for the 10% and 13% Cap Alternatives.

Table 4-4. Escapement projections to natural areas under the de minimis fishery alternatives, 1985-2006 (thousands). Seasons with no change in projections are omitted from the table for clarification. The actual spawner reduction rates are shown in Table 4-5.

	Alternative			
Season	Status Quo	5% Cap	10% Cap	13% Cap
1985	35.0	33.4	28.9	25.4
1986	35.0			
1987	51.6			
1988	44.4			
1989	51.3			
1990	35.0			
1991	35.0		32.1	28.3
1992	26.0	22.3	18.9	16.5
1993	35.0			
1994	35.0			
1995	35.0			
1996	58.3			
1997	35.0			
1998	35.0		32.8	28.8
1999	35.0		32.9	28.6
2000	35.0			
2001	43.1			
2002	35.0			
2003	35.0			
2004	35.0			
2005	35.0		32.6	28.5
2006	32.5	27.7	23.2	20.1

4.2.2 Results

Implementation Frequencies and Impacts

The Hindcast Analysis of *de minimis* fishery alternatives is shown in Table 4-4. Calculations for "no change" cells have been eliminated to facilitate the comparisons. The average SRRs for the 5%, 10% and 13% Cap Alternatives are 13%, 25% and 35% respectively (Table 4-5). Thus, ocean fishery age-4 impact rates for fixed cap alternatives expressed as a proportion of their respective SRRs were 38%, 40%, and 38%.

In two years (9%), 1992 and 2006, the Status Quo Alternative required ocean fishery closure to eliminate impacts on KRFC (Table 4-4). In all other years, some level of fishing was allowed under the Status Quo Alternative, albeit at a very low level in some years. The 5% Cap Alternative provided *de minimis* fishing in three years (14%) while the 10% and 13% Cap Alternatives each provided *de minimis* fishing opportunity in seven years (32%).

As noted above the Hindcast Analysis is static and does not include effects of the stock recruitment relationship on future years if de minimis fisheries were implemented. The analysis indicates that as the allowable impact rate increases, the likelihood of consecutive years of *de minimis* fisheries increases, and therefore the frequency of spawner escapements less than the 35,000 floor increases. This in turn increases the risk of the stock triggering an Overfishing Concern.

Table 4-5. Spawner reduction rates (SRR) for de minimis fishery alternatives, 1985-2006 seasons.

Season	Alternative Status Quo	5% Cap	10% Cap	13% Cap
1985	**8.8%**[a/]	**12.9%**	**24.7%**	**33.6%**
1986	**57.1%**	11.5%	21.3%	29.8%
1987	**66.7%**	13.0%	24.8%	33.9%
1988	**66.7%**	14.0%	26.9%	36.5%
1989	**66.7%**	13.6%	26.0%	35.3%
1990	**59.1%**	12.1%	22.4%	31.4%
1991	16.4%	12.5%	**23.5%**	**32.4%**
1992	**0.0%**	**14.1%**	**27.2%**	**36.6%**
1993	**35.3%**	11.5%	21.3%	30.0%
1994	**35.5%**	13.3%	25.5%	34.6%
1995	**36.1%**	12.0%	22.4%	31.3%
1996	**66.7%**	13.1%	25.1%	34.2%
1997	**36.8%**	13.6%	25.7%	35.4%
1998	19.4%	12.9%	**24.4%**	**33.7%**
1999	22.7%	14.1%	**27.2%**	**36.6%**
2000	**42.7%**	11.4%	21.0%	29.6%
2001	**66.7%**	14.0%	27.2%	36.5%
2002	**63.1%**	14.4%	27.8%	37.5%
2003	**59.8%**	14.3%	27.5%	37.2%
2004	**51.6%**	15.6%	30.4%	40.6%
2005	19.9%	13.4%	**25.3%**	**34.7%**
2006	**0.0%**	**14.7%**	**28.5%**	**38.2%**
Average		**13.3%**	**25.3%**	**34.5%**

a/ potentially viable alternatives are shown in bold font.

The age-4 ocean impact rate caps for each of the alternatives were approximately 40% of average SRRs for those alternatives displayed at the bottom of Table 4-5. This was similar to the values reported for this relationship in Section 4.1.1.

The 5%, 10%, and 13% Cap Alternatives lowered the average natural escapements in the years they were implemented by 11%, 14%, and 25%, respectively, compared to the Status Quo Alternaitve (Table 4-6).

Table 4-6. Comparison of projected spawner escapement statistics for *de minimis* fishery alternatives compared to the Status Quo Alternative (see Table 4-4 for data).

Alternative	Implementation Data: Number	Averages: Status Quo	Averages: Alternative	Range	Decline from Status Quo
5% Cap	3	31.2	27.8	22.3 - 33.4	11.0%
10% Cap	7	33.4	28.8	18.9 - 32.8	13.7%
13% Cap	7	33.4	25.2	16.5 - 28.8	24.5%

Probabilities of Alternatives Relative to Evaluation Criteria

The frequency of CAYs in the bootstrap analyses were similar between the Status Quo Alternative and 5% Cap Alternatives, but increased substantially under the 10% and 13% alternatives (Table 4-7). The mean probability of a CAY increased from 9% and 13% under the Status Quo and the 5% Cap Alternatives, respectively, to 31% each for the 10% and 13% Cap Alternatives (Table 4-8).

Table 4-7.Proportion of 40-yr bootstrap samples for individual alternatives falling within Conservation Alert Year (CAYs) frequencies ranging from zero to 16-40 events.

Frequency of CAYs	Alternative			
per 40-yr sample	Status Quo	5% Cap	10% Cap	13% Cap
0	3.0%	1.0%	0.0%	0.0%
1	5.0%	2.0%	0.0%	0.0%
2	18.0%	4.0%	0.0%	0.0%
3	32.0%	11.0%	0.0%	0.0%
4	15.0%	24.0%	0.0%	0.0%
5	16.0%	15.0%	0.0%	1.0%
6	8.0%	17.0%	1.0%	0.0%
7	1.0%	11.0%	4.0%	1.0%
8	1.0%	8.0%	5.0%	7.0%
9	0.0%	4.0%	3.0%	4.0%
10	1.0%	2.0%	16.0%	5.0%
11	0.0%	0.0%	12.0%	15.0%
12	0.0%	1.0%	20.0%	19.0%
13	0.0%	0.0%	11.0%	16.0%
14	0.0%	0.0%	5.0%	12.0%
15	0.0%	0.0%	6.0%	10.0%
16-40	0.0%	0.0%	17.0%	10.0%

Table 4-8. Probabilities of conservation alerts and Overfishing Concerns in 40-yr time period bootstrap samples.

	Alternative			
Category	Status Quo	5% Cap	10% Cap	13% Cap
<35,000 Natural Spawning Escapement	0.09	0.13	0.31	0.31
1+ Overfishing Concerns (<35K in 3 Consecutive Years)	0.03	0.03	0.59	0.58
2+ Overfishing Concerns	0	0.01	0.26	0.21
3+ Overfishing Concerns			0.05	0.04
4+ Overfishing Concerns				0.01

The probability of an OC occurring one or more times in a 40-yr time period increased in the bootstrap analysis from 3% for the Status Quo and 5% Cap Alternatives to 59% and 58%, respectively, for the 10% and 13% Cap Alternatives. The frequency of multiple OCs also increased between the former alternatives and the latter alternatives (Table 4-9).

Table 4-9. Proportion of 40-yr bootstrap samples with zero or more Overfishing Concerns.

	Alternative			
Frequency of Overfishing Concerns	Status Quo	5% Cap	10% Cap	13% Cap
0	97.0%	97.0%	41.0%	42.0%
1	3.0%	2.0%	33.0%	37.0%
2	0.0%	1.0%	21.0%	17.0%
3	0.0%	0.0%	5.0%	3.0%
4	0.0%	0.0%	0.0%	0.0%
5	0.0%	0.0%	0.0%	1.0%

Carry-over Effect of De Minimis Fishing Alternatives

The effect of *de minimis* fishing on ocean population sizes of age-4 and age-5 fish and natural spawning escapements in subsequent years were examined for a 16% Cap Alternative, although that alternative was subsequently eliminated from further consideration. All of the remaining alternatives have lower impact on KRFC than the 16% Cap Alternative; therefore the analysis represented an upper bound of potential carry-over effects. The analysis indicated the carry-over effect had a small (<1.5%) overall impact on ocean population sizes of age-4 and age-5 fish. In years in which there was carry-over effect the population reductions were 1.1% and 3.9% for age-4 and age-5 fish, respectively. The reduction in natural spawners in the absence of fishing for years in which there was carry-over effect was about 0.2%.

The 16% Cap Alternative reduced natural spawning runs in two critically low years by 200 and 300 adults (1% each) (Appendix F). The 16% Cap Alternative was less restrictive than the Council's final *de minimis* fishing alternatives so it can be inferred that the more restrictive alternatives for ocean fishing opportunity would have lower carry-over effects.

4.3 Population Viability Analysis (PVA)

The biological analysis projected the effects of *de minimis* fishery implementation at various levels on future population size and fishery harvest. Projections were based on a Population Viability Analysis (PVA) using a stochastic, age-structured, stock-recruitment population model (SSRM). A PVA is conceptually the same approach that has been applied to the identification of take limitations based on impact levels deemed to pose no jeopardy to future viability for ESA listed salmon stocks. The SSRM is an adaptation of the model previously used by Prager and Mohr (1999; 2001) to evaluate the effects of fishery alternatives.

4.3.1 Analytical Methods

Model Description

The SSRM estimates annual fish numbers, harvest, and fishery impacts based on various fishery strategies including the historical management plan, the Status Quo, and *de minimis* fishing Alternatives. The fish population portion of the SSRM estimates age-specific numbers of natural and hatchery-produced fish in the ocean, returning to the river, and escaping fisheries to return to natural spawning areas or hatcheries. The fishery portion of the SSRM represents fisheries in the ocean (all areas aggregated) and in the Klamath River system (river tribal, and river recreational). Fishery variables include encounter, harvest, and impact numbers and rates. The model is configured using historical KRFC data on natural and hatchery production, survival, and maturation rates. Fishery parameters include age and fishery-specific vulnerabilities, legal fractions, catch-release mortality rate, and drop-off mortality rate as well as the prescribed allocation of harvest among fisheries (described in Section 1.4.2). The fishery model structure and input variables in the KOHM are described by Prager and Mohr (1999).

The SSRM couples fishery dynamics with a Ricker stock-recruitment function in a stochastic framework. A stochastic approach allows explicit analysis of conservation and future fishery risks associated with fishing at low population levels. The model includes uncertainty and variability in both fish population and fishery dynamics. Stochastic simulations involve multiple iterations (e.g., 200) of a 40 year time interval beginning with current conditions. The 40 year period was based on the spawning escapement policy for KRFC (KRTT 1986). Results are expressed in terms of averages, variances, ranges, and frequency distributions. Risks were expressed based on probabilities of various outcomes (e.g., probability of future spawning escapement of less than 35,000 fish).

Stock Recruitment Analysis

The stock/recruitment relationship for KRFC is an important component of the PVA for evaluating the effect of various *de minimis* fishing alternatives on the long-term production potential of the stock. Stock and recruitment data are available for naturally spawning KRFC for the 1979-2000 broods. The STT analyzed the data for estimating stock size at sustainable equilibrium production (S_{EQ}), maximum sustainable production (S_{MSP}) and maximum sustainable yield (S_{MSY}) for naturally-spawning KRFC. They used three different models in the analysis: Model 1 was based on a single variable -- adult stock size; Model 2 incorporated juvenile life history survival rates as a second variable (as indicated by hatchery fish survival data); and Model 3 used a watershed size-based approach currently under development by Canadian biologists (STT 2005) (Table 4-10). The Model 2 approach was used in the SSRM as recommended by the STT and SSC (2005) as representing the best available science. Sensitivity analyses were used to relate the relative importance of the various input parameters such as the Ricker curve α and β parameters. A depensatory function was activated when escapements were below 35,000 to further lower productivity/recruitment due to depressed population effects. Depensation effect due to inbreeding depression was not carried through to subsequent generations. It was recognized that depensation effect may persist until variability could be re-established in the genome. Over a 40-year time frame (10 generations) the effect could be quickly masked by a few high production years.

Table 4-10. Spawner reference points for Ricker stock-recruitment Models 1, 2, and 3 (Reference: STT 2005b).

Spawner Reference Point	Model 1 (Parent Spawners)	Model 2 (Parent Spawners, Survival)	Model 3 (Watershed Area)
S_{EQ}	101,300	112,300	185,000
S_{MSP}	39,700	56,900	111,200
S_{MSY}	32,700	40,700	70,900

Mid-Klamath Basin Sub-stock Analysis

The major mid-Klamath Basin natural spawning stocks include the Salmon, Shasta, and Scott Rivers. These runs have had minimal or no hatchery fish influence during the period of annual escapement monitoring, which extends to 1978. The average adult fall Chinook salmon spawning run to these rivers ranges from 2,400 for the Salmon River to 4,600 for the Scott River (Table 4-11). The annual run size ranges have been quite variable particularly for the Scott and Shasta rivers (Table 4-11 and Figure 4-1). Regression analysis of available river run size data shows a fairly close relationship between the individual run size and total Klamath Basin natural run sizes (Table 4-11).

Based on published studies and age composition data for KRFC, mid-Klamath basin run sizes of less than about 720 spawning adults substantially increases the risk of loss of genetic diversity (Appendix D). The historical record showed 6 of 28 years (21%) with a tributary spawning run of less than 720 adults, including 2004 and 2005 (Figure 4-1). The population numbers for individual streams have generally rebounded, but any adverse genetic impacts as a result of low escapement would be difficult to measure.

The relationships of the individual mid-Basin adult Chinook salmon runs to the total Klamath Basin natural run size were analyzed by the SAC using standard statistical methods for the probability that the number of spawning adults in at least one of the mid-Basin streams would fall below 720 spawning adults in any year (Appendix D). The statistical relationship for these streams was then used in the SSRM to estimate the probability of any mid-Basin adult escapement falling below 720 spawners under each of the Council's *de minimis* fishery alternatives.

Table 4-11. Escapement statistics and regression results for mid-Klamath Basin and other Klamath Basin natural Chinook salmon populations, 1981-2005.

	Spawning Escapement				Regressions[a/]		
Drainage	Mean	Range (000s)	Std. Dev	C.V.	y	r-square	Description
Salmon	2,383	0.3-5.8	1,512	0.63	0.037	0.712	Salmon on Basin
Scott	4,569	0.4-12.0	3,335	0.73	0.080	0.808	Scott on Basin
Shasta	3,732	0.4-12.8	3,326	0.89	0.067	0.735	Shasta on Basin
Total mid basin	10,684	1.6-28.2	6,386	0.60	0.184	0.888	Mid basin on Basin
Total other naturals	40,728	7.6-133.6	32,980	0.81			
Total Basin	51,412	11.6-161.8	38,020	0.74			

a/ All regression were run through the origin.

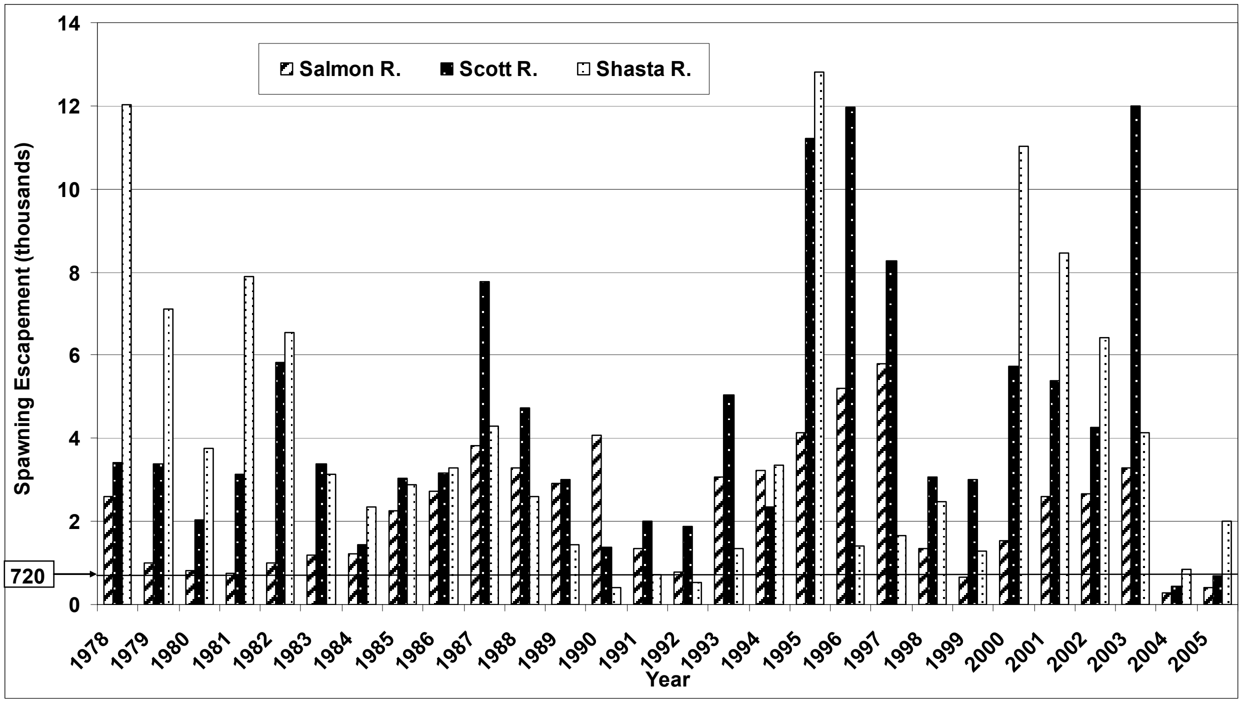

Figure 4-1. Mid-Klamath basin sub-stock spawning escapement and critical level, 1981-2005.

Model Estimation Error

The SSRM included a fishery variance term to capture the effects of forecast error and variable fishing success on fishing rates. Fishery management variance results from the effects of uncertain forecasts, effort, and catch rates which are reflected in differences between in-season target and post-season actual fishing rates.

The STT uses the KOHM to evaluate ocean fishery regulatory alternatives in the context of meeting 1) ocean and inriver fishery allocation agreements or requirements and 2) the natural spawning population conservation objective for the stock. The STT makes annual projections of 1) ocean abundance of ages-3, age-4 and age-5 fish, 2) the number of adult fish by age class that will mature and enter the river, and 3) the number of fish that will spawn in natural areas of the Basin. The data series began with the 1988 season, the first year of harvest rate management of KRFC, as agreed to by the KFMC. The comparisons were based on annual deviations during 1988-2005 in post season estimates compared to pre-season projections (i.e., pre-season estimates/ post-season estimates).

Variation or error in estimates from fishery models like the KOHM were due to a mix of biological, environmental, and fishery management system factors. Model error is commonly measured by comparing a prediction to an actual outcome. Several types of pre- and post season estimates were used to measure error for KRFC modeling (Table 4-12). The data show that ocean abundance projections of age-4 fish have been overestimated by 21-34% depending on how the statistics were averaged (arithmetic or geometric means). Ocean age-3 fish were overestimated by 14% using a simple arithmetic average and underestimated by 10% using a geometric average. The pre-season maturity rate projections that determine the spawning escapement estimate were on average quite close for both age groups, but the coefficient of variation (CV) for the deviation in the age-3 projection was high (64%) indicating a wide range in statistical probability of the "average" for the population. The estimate of fish spawning in natural areas was on average very close to the post-season estimate with a relatively low CV of 19%. Ocean fishery harvest rate for age-4 fish was on average below the post-season estimate by nearly 16 percentage points with a relatively high CV of 41%. This indicates the KOHM was, on average, underestimating ocean fishery catches and impacts. As is common for many salmon populations, the accuracy of the pre-season projections of natural spawning escapement was low (CV of 68%). On average the pre-season predictions were high by about 29%, based on the arithmetic mean, but very close (2%) based on the geometric mean. The data indicate that natural spawning stock projection inaccuracies generally occurred in cycles of 4-5 years rather than at random (Figure 4-2). The apparent serial pattern in the data may be due to changes or updates in projection model parameters or in the assumptions used in the modeling. However, the amount of error in the predictions does not appear to have decreased over time. This suggests that these patterns are reflecting shifting environmental conditions. Estimation errors of a biological or management nature similar to those shown in Table 4-12 are incorporated into the SSRM to account for the uncertainty or risk associated with the adoption of any of the Council's *de minimis* fishery alternatives (Appendix G). However, no bias correction was made for underestimates of ocean fishery harvest rates because of the corrections that were made to the KOHM beginning in 2006 (STT 2006c)

Table 4-12. Pre- and post season estimation statistics. See Appendix G for additional details.

	Ocean Abundance		Maturity Rate		Natural Area	Age-4 Ocean	Natural
Statistic	Age-3	Age-4	Age-3	Age-4	Proportion	Harvest Rate	Spawner Goal
Mean (pre/post)	1.137	1.343	1.161	1.003	1.101	0.839	1.285
Geometric Mean	0.899	1.214	1.016	1.002	1.083	0.771	1.016
Variance	0.629	0.386	0.548	0.002	0.043	0.117	0.765
SE	0.187	0.146	0.198	0.012	0.049	0.081	0.206
SD	0.793	0.621	0.74	0.045	0.208	0.342	0.874
CV	0.698	0.463	0.637	0.045	0.189	0.408	0.681
Median	1.137	1.277	0.896	0.993	1.116	0.793	0.962

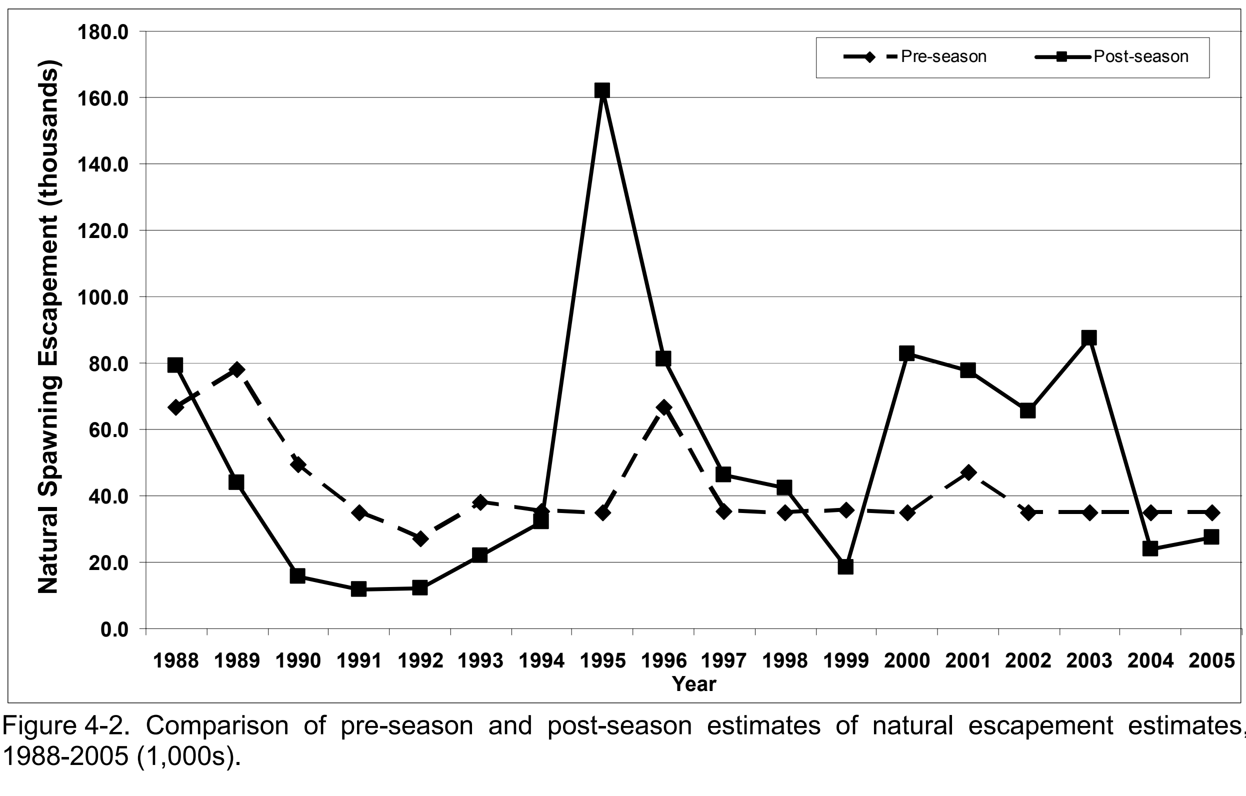

Figure 4-2. Comparison of pre-season and post-season estimates of natural escapement estimates, 1988-2005 (1,000s).

4.3.2 SSRM Results

Results for 1 to 40-year periods generally are used for comparison of the alternatives in the following analysis. Results are also available for 1 to 5-year and 6 to 40-year periods.

Analyses of fishery alternatives confirm that *de minimis* fishing rates of 10% or less have a limited effect on the incidence of spawning escapements of less than 35,000 (Table 4-13). The5% , 10%, and 13% Cap Alternatives increase the risk of run size less than 35,000 by 1%, 3%, and 5% respectively, over that of the Status Quo Alternative.

The risk of run sizes less than 12,000 increased by absolute values of <1%, 1%, and 2%, respectively, compared to the Status Quo Alternative (Table 4-13).

The probability of spawning escapements in any one year of less than 720 in mid-Klamath tributaries (Shasta, Scott, and Salmon rivers) were increased by <1%, 3% and 6% greater for the 5%, 10%, and 13% Cap Alternatives, respectively, compared with the Status Quo Alternative (Table 4-13).

The probabilities of meeting egg collection goals at Klamath Basin hatcheries were similar among all the alternatives, ranging from 69% for the 13% Cap Alternative to 71% for the Status Quo Alternative (Table 4-13).

The probabilities of the age-4 ocean harvest rate exceeding 16.0% (CCC ESA consultation standard) ranged from 39% for the Status Quo Alternative to 44% for the 13% Cap Alternative. These deviations were due to the management error estimates used in the SSRM model runs. (Table 4-13).

De minimis fisheries would occur in 15%-24% of years under the fixed cap alternatives (Table 4-13). The increased frequency is related to differences in threshold levels for implementation among the alternatives and may not relate to differences in catch, economic impact, or escapement numbers.

The average frequency of three consecutive years of escapements less than 35,000 (triggering an Overfishing Concern) increased from 2.19 events per 40-year period under the Status Quo Alternative to 2.87 events per 40-year period under the 13% Cap Alternative (Table 4-13).

Average ocean harvest and spawning escapement of KRFC were little affected by the implementation of *de minimis* alternatives. The small numbers of fish affected during *de minimis* fishery implementation (1-5 years) did not contribute significantly to the long term averages. Harvest benefits of small fisheries in *de minimis* fishing years were partially offset by decreased future production due to lower spawner escapement effects (Table 4-13).

The difference in average annual Tribal fishery harvest was less than 500 fish between the Status Quo Alternative and the 13% Cap Alternative. For the river recreational fishery the difference was less than 40 fish (Table 4-13).

The 13% Cap Alternative produces long term average natural escapement of about 68,400 compared to 72,400 under the status quo alternative. All figures are substantially greater than the 40,700 spawners estimated to produce MSY (Table 4-10).

The model also tracks results separately in years 1-5 and years 6-40 of the simulation period in order to assess short-term and long-term risks. Because of recent low numbers of spawners, short-term catch and escapement projections are lower than long-term projections. (Table 4-13).

Table 4-13. Key results from KRFC SSRM for *de minimis* fishing alternatives using 200 iterations of 40 year time series.

	Alternative[a]			
Key Factors:	Status Quo[b]	5% Cap[c]	10% Cap[d]	13% Cap[e]
Years Spawning Escapement < 35,000[f]	0.271	0.284	0.305	0.320
Years 1-5	0.461	0.485	0.518	0.534
Years 6-40	0.244	0.255	0.274	0.289
Years Spawning Escapement <12,000[g]	0.011	0.014	0.021	0.031
Years 1-5	0.019	0.023	0.029	0.064
Years 6-40	0.009	0.013	0.019	0.026
Years Tributary Spawning Escapement <720[h]	0.149	0.159	0.177	0.193
Years 1-5	0.221	0.248	0.292	0.330
Years 6-40	0.139	0.147	0.160	0.221
Years Egg Take ≥ Goal[i]	0.705	0.702	0.698	0.689
Years Age-4 Ocean Harvest Rate ≥ 0.16[i]	0.389	0.388	0.400	0.437
Years 1-5	0.264	0.260	0.284	0.356
Years 6-40	0.407	0.406	0.416	0.448
Years Alternative Implemented[j]	0.147	0.148	0.199	0.237
Frequency of Overfishing Concerns in 40 Years[k]	2.19	2.37	2.63	2.87
Average Annual KRFC Ocean Harvest; Troll and Sport Combined	32,832	33,061	33,305	33,469
Years 1-5	21,086	21,672	22,291	22,730
Years 6-40	34,510	34,689	34,878	35,003
De minimis Years Only	--	3,672	7,950	11,028
Average Annual Tribal Harvest	48,834	48,798	48,589	48,313
Years 1-5	33,010	33,219	33,321	33,295
Years 6-40	51,095	51,023	50,770	50,458
De minimis Years Only	--	2,764	6,277	8,584
Average Annual River Recreational Harvest	12,071	12,081	12,063	12,036
Years 1-5	8,331	8,376	8,366	8,330
Years 6-40	12,605	12,610	12,591	12,565
De minimis Years Only	--	706	1,551	2,158
Average Annual Natural Spawning Escapement	72,444	71,470	69,845	68,423
Years 1-5	58,002	55,897	52,916	50,408
Years 6-40	74,507	73,694	72,263	70,996
De minimis Years Only	--	40,627	38,691	37,996

a/ All Alternatives include the CCC ESA consultation standard limitation of ≤16.0% age-4 ocean harvest rate (landed catch only; ≈17% age-4 ocean impact rate).

b/ No fishing when projected natural spawning escapement <35,000.

c/ *De minimis* fishing limited to no more than a 5% age-4 ocean impact rate with a threshold of unfished natural spawning escapement of less than about 40,000.

d/ *De minimis* fishing limited to no more than a 10% age-4 ocean impact rate with a threshold of unfished natural spawning escapement of less than about 47,000.

e/ *De minimis* fishing limited to no more than a 13% age-4 ocean impact rate with a threshold of unfished natural spawning escapement of less than about 52,000.

f/ Probability of an escapement less than the 35,000 natural spawner floor (KRFC conservation objective) in any one year.

g/ Probability of an escapement less than 12,000 natural spawners (lowest on record) in any one year.

h/ Probability of a major mid-Klamath tributary (Shasta, Scott, or Salmon rivers) escapement less than 720 natural spawners (genetic/long-term productivity risk) in any one year.

i/ Probability of not meeting the ESA consultation standard for California Coastal Chinook ESU age-4 coean harvest rate ≤ 16.0%) in any one year.

j/ Probability that a *de minimis* fishery alternative, or no fishing in the case of the Status Quo Alternative, will be implemented (no fishing spawning escapement is less than the threshold) in any one year.

k/ Number of independent Overfishing Concerns triggered during the 40 year simulation period.

4.4 Economic Analysis of De Minimis Fishing

The relative change in estimated economic impacts of the alternatives depends on the distribution of allowable harvest rates or levels among ocean commercial and recreational fishing sectors and areas and river tribal and recreational fisheries. The economic analysis approach was: 1) develop ocean fishing regulation scenarios for each of the de minimis fishing alternatives for a Conservation Alert Year (CAY), 2) estimate fishing effort effects for a CAY and long-term as appropriate, and 3) compute economic impacts for ocean and river fisheries for each of the CAY scenarios and long-term for the respective fisheries based on the SSRM. Economic impact estimates were developed separately for ocean troll and sport fisheries by open fishing area and month, and for annual river tribal and river recreational fisheries.

Fishing effort effects are particularly important to quantify for ocean and river recreational fisheries, which depend primarily on fishing time and secondarily on level of catch, in terms of economic impacts. Fishing effort in the troll fishery is also important for this analysis because of the method used for projecting catch in a CAY and long-term based on different troll fishery success levels.

4.4.1 Fishing Regulation Scenarios

The *de minimis* fishery alternatives for a Conservation Alert Year (CAY) are expressed in terms of allowable ocean impact rates on KRFC. As part of the annual regulation process these allowable rates are implemented through a set of ocean fishing regulations that allocate impacts among fishing sectors and areas. Here we examine the general level of ocean and river fishing that would likely be associated with each of the Alternatives. Ocean fishing regulation scenarios for a CAY were developed for each Alternative using the final 2006 KOHM.

The KOHM does not project fishery impacts or effort for fall (September-December) fisheries. Fall catches of KRFC are input each year for use in analyzing following spring and summer fishing regulation effects on KRFC. Average recent year effort and Chinook salmon catch by fishery, port area, and month for annual and fall fisheries were discussed in Sections 3.3.4 and Section 3.3.5, respectively. The data showed that fall fisheries support substantial fishing effort and Chinook salmon catch particularly off Oregon and in the KMZ.

Many ocean fishing regulation scenarios would meet the respective *de minimis* fishing objectives. The scenarios presented here provide a reasonable and consistent context for comparison of the economic impact of the de minimis alternatives. The 2006 KOHM uses preseason forecasts of abundance of non-Klamath Chinook salmon stocks to estimate catches by fishery, area and open fishing period. Another approach would be to input post-season contribution rate data to the KOHM, which would produce more accurate total catch information. It is not clear that the regulation scenarios would be substantially different from the ones presented here.

The ocean population size and age structure of KRFC in 2006 did not allow for any ocean fishing in 2006, except by emergency rule. Depressed KRFC stock size is possible for at least the next two years, so 2006 was determined to be an appropriate year upon which to base this analysis. The 2006 KOHM contains the most current parameters for estimation of fishery impacts. The following regulation criteria were used for all the alternatives:

1. Ocean sport fishing seasons outside of the KMZ were set to recent full fishing levels except for the Status Quo Alternative, which was based on Conservation Alert Year had all fisheries closed except the Fort Bragg recreational fishery during February-March and the Oregon coast recreational fishery during March and April,
2. The unusually large fall 2005 troll fishery catch was eliminated, but the sport catch was retained,
3. Traditional fishery minimum size limits were used (20 inches TL sport, 26 inches TL troll),

4. The river allocation was set to 15% of the preseason projected total non-tribal harvest share,
5. The KMZ sport allocation goal was 17% of the ocean harvest share,
6. The CA-OR troll fishery allocation goal was 50-50,
7. The river tribal allocation was 50% of the preseason projected catch of KRFC, and
8. The troll fishing season was from February 15-August 31 (fall fishing for the coming season was not evaluated).

These assumptions were made to approximate traditional ocean fishery management and because fall 2005 troll catch had an unusually high impact on the stock. The sport fishing regulations outside the KMZ were set at full fishing levels because these fisheries with full recreational fishing seasons had an age-4 impact rate of <1% based on the 2006 KOHM. The recreational salmon fisheries with no known impact on KRFC were left open in the Status Quo Alternative (STT 2006b).

The primary objective of the ocean fishery regulation scenarios for each *de minimis* fishery alternative was to maximize the catch on non-KRFC in ocean fishing areas between Cape Falcon and Point. Sur. The scenarios were developed without regard to local fishery needs, which is a recognized important consideration in the Council regulation process. It was not the intent of this process to suggest how ocean fishery allocations should be developed but do provide a plausible and consistent scenario for comparison of the alternatives KRFC contribution rates measured as a proportion of all stocks caught in the fisheries from the KOHM were used to construct the troll and KMZ sport season scenarios (Table 4-14). Priority cells for allowing fishing were those with the lowest impact on KRFC. Effort shift effects (depending on whether adjacent areas were open or closed) were taken into account in deciding and analyzing open fishing periods. Troll fishery impacts on coho salmon were not factored into the season structure scenarios, but it was recognized this is an important part of the annual season setting process.

Table 4-14. 2006 KOHM ocean salmon fishery contribution rates for KRFC. Bold font indicates high priority months for de minimis fisheries, italic font indicates medium priority months, and standard font indicates low priority months.

Fishery/	Month											
Area	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Troll												
NO	0.01	0.01	0.00	NA	NA	NA	*0.09*	**0.04**	**0.05**	**0.02**	**0.04**	**0.05**
CO	0.07	0.08	0.00	0.00	0.00	NA	**0.04**	**0.04**	*0.07*	*0.07*	*0.12*	0.20
KO	0.08	0.00	0.00	NA	NA	NA	NA	NA	0.25	0.23	0.29	0.19
KC	0.04	NA	NA	NA	NA	NA	NA	NA	0.48	0.31	0.15	0.13
FB	0.01	NA	NA	NA	NA	NA	NA	NA	0.14	0.13	0.15	0.05
SF	0.01	0.00	NA	NA	NA	NA	NA	NA	0.04	0.04	*0.03*	**0.01**
MO	0.00	NA	NA	NA	NA	NA	NA	NA	**0.01**	**0.01**	*0.03*	**0.00**
Recreational												
NO	0.03	0.00	NA	NA	NA	NA	NA	NA	0.07	0.02	0.02	0.04
CO	0.01	0.00	NA	NA	NA	NA	NA	NA	0.32	0.04	0.03	0.02
KO	0.11	0.00	NA	NA	NA	NA	NA	NA	**0.07**	**0.07**	*0.10*	*0.16*
KC	0.14	NA	NA	NA	NA	NA	NA	NA	**0.09**	**0.07**	*0.08*	*0.14*
FB	0.00	0.00	NA	NA	NA	NA	NA	0.04	0.06	0.04	0.03	0.05
SF	0.00	0.00	0.00	NA	NA	0.01	0.00	0.01	0.01	0.02	0.01	0.00
MO	0.00	NA	NA	NA	NA	NA	0.01	0.01	0.00	0.00	0.01	0.04

The regulatory scenario developed for the least restrictive ocean fishing alternative (13% Cap Alternative) was used as the base for reduction in fishing time for each of the more restrictive alternatives. The season structure scenarios associated with each *de minimis* fishing alternative were shown in Tables 4-15 and 4-16. An open fishing days calendar for the adopted May-August 2006 troll season and the adopted 2006-2007 recreational seasons were included in these tables for comparison.

Table 4-15. Calendar of troll season scenarios for *de minimis* fishing alternatives. Days open are shown by regulation scenario, area and month. Only spring/summer troll fisheries were open for this analysis.

	Month											
Area[a/]	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Status Quo												
NO												
CO												
KO						No Fishing						
KC												
FB												
SF												
MO												
5% Cap												
NO								28	31	30		
CO								28				
KO												
KC												
FB												
SF												31
MO									7			31
10% Cap												
NO								30	31	30		
CO							11	30				
KO												
KC												
FB												
SF												31
MO									31	5		31
13% Cap												
NO								30	31	30	7	
CO							17	30				
KO												
KC												
FB												
SF												31
MO									31	14		31
2006 Season												
NO										12	9	3
CO												
KO												
KC												
FB												
SF											6	31
MO									31		6	31

a/ NO=Northern Oregon (Tillamook/Newport); CO=Central Oregon (Coos Bay); KO=Oregon KMZ (Brookings); KC=California KMZ (Crescent City/Eureka); FB=Fort Bragg; SF = San Francisco; MO=Monterey.

Table 4-16. Calendar of ocean recreational fishing season scenarios for *de minimis* fishing alternatives. All regulations were based on 2005 except KMZ regulations (in gray) during May-Aug., which were constructed to meet 17% KRFC ocean catch allocation objective. Days open are shown by regulation scenario, area, and month. Oregon state waters fisheries are shown in parentheses.

	Month											
Area[a/]	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Status Quo												
NO			(15)				17	30				
CO			(30)	(15)			17	30				
KO												
KC												
FB	30	31	13			11	31					
SF		31	13									
MO	25											
5% Cap												
NO	30	31	(15)				17	30	31	30	31	31
CO	30	31	(30)	(15)			17	30	31	30	31	31
KO	11	(12)							7	15		
KC	11								7	15		
FB	30	31	13			11	31	30	31	30	31	31
SF	30	31	13					30	31	30	31	31
MO	25							30	31	30	31	31
10% Cap												
NO	30	31	(15)				17	30	31	30	31	31
CO	30	31	(30)	(15)			17	30	31	30	31	31
KO	11	(12)							31	30	20	
KC	11								31	30	20	
FB	30	31	13			11	31	30	31	30	31	31
SF	30	31	13					30	31	30	31	31
MO	25							30	31	30	31	31
13% Cap												
NO	30	31	(15)				17	30	31	30	31	31
CO	30	31	(30)	(15)			17	30	31	30	31	31
KO	11	(12)							31	30	31	14
KC	11								31	30	31	14
FB	30	31	13			11	31	30	31	30	31	31
SF	30	31	13					30	31	30	31	31
MO	25							30	31	30	31	31
2006-2007 Season												
NO	30	31	(15)				17	30	31	30	31	31
CO	30	31	(30)	(15)			17	30	31	30	31	31
KO	6	(12)							17	30	4	
KC	6								17	30	4	
FB	30	31	12			11	31	30	31	17	19	31
SF	30	31	12					24	31	28	28	31
MO	24							24	31	30	31	31

a/ NO=Northern Oregon (Tillamook/Newport); CO=Central Oregon (Coos Bay); KO=Oregon KMZ (Brookings); KC=California KMZ (Crescent City/Eureka); FB=Fort Bragg; SF = San Francisco; MO=Monterey.

Catch Estimates

Estimated catches of KRFC for the *de minimis* fishery regulation scenarios based on a CAY increased from zero fish under the Status Quo Alternative to 22,100 fish under the 13% Cap Alternative (Table 4-17). The proportion of the catch of KRFC increased in the troll fishery from 26% to 32% between the 5% and 13% Cap Alternatives while the proportion in the recreational fishery outside of the KMZ declined from 10% to 4%. The allocations between the ocean troll fisheries, the KMZ recreational fishery, and the river tribal and recreational fisheries were consistent with the allocation objectives described above and in Section 1.4.2.

Table 4-17. Ocean and river catch levels of KRFC for a Conservation Alert Year by area and fishery for each ocean fishery regulation scenario.[a/]

			Alternative					
			5% Cap		10% Cap		13% Cap	
Area	Fishery	Status Quo	Number	Proportion	Number	Proportion	Number	Proportion
Ocean	KMZ Rec	0	679	0.07	1,229	0.07	1,600	0.07
	Other Rec	0	908	0.10	884	0.05	873	0.04
	CA Troll	0	1,197	0.13	2,590	0.15	3,482	0.16
	OR Troll	0	1,221	0.13	2,590	0.15	3,426	0.16
	Total	0	4,005	0.43	7,293	0.43	9,381	0.43
River	Tribal	0	4,712	0.50	8,580	0.50	11,036	0.50
	Rec	0	706	0.07	1,287	0.08	1,655	0.07
	Total	0	5,418	0.57	9,867	0.57	12,691	0.57
All	Total	0	9,423	1.00	17,160	1.00	22,072	1.00

a/ Estimates are based on September 1, 2005 ocean abundance levels of KRFC, the regulation scenarios shown in Tables 4-15 and 4-16, and using the final 2006 KOHM.

Ocean Fisheries Effort Estimates

Ocean troll and recreational fishery effort estimates for a CAY were produced by 2006 KOHM runs based on the ocean fishing scenarios described above. For the recreational fishery the estimates were monthly angler days of effort during open fishing periods and for the troll fishery were monthly boat days during open fishing periods. Effort shifts were used in the analysis depending on whether adjacent cells were open in the same months. Long-term (40-year) effort levels for the troll fishery under different troller success rate scenarios were calculated based on projected catch levels using the SSRM (see Appendix H).

Tribal Fishery Effort Estimates

Tribal fishery economic impacts were estimated based on projected catch levels for both a CAY and long-term using the SSRM. Tribal fishing effort was not a factor in the analysis.

River Recreational Fishery Effort Estimates

River recreational fishery effort estimates, both for a CAY and long-term using the SSRM, were based on Lower Klamath River (below Coon Creek falls, river mile 35) fishery information for years since 1980 when annual river recreational fishery sampling was implemented (Appendix I). The data show that recreational Chinook salmon angler success rate appears to be related to allowable catch level of adult Chinook salmon. This was likely due to a combination of factors including fish density effect on angler success rate and because regulations were adopted in higher quota years to allow anglers to catch and possess more fish.

A least squares regression was used to project recreational fishery angler effort based on projected Chinook salmon catch. The regression was based on the average annual adult Chinook salmon catch per angler trip on Chinook salmon catch during 1980-2005 (Appendix I). This approach assumes the lower river fishery catch per unit of effort for adult Chinook salmon is representative of the basin as a whole. Steelhead trout angling trips were not differentiated in the sampling so it is not known how much of the effort during those years was directed at adult Chinook salmon, a combination of the two species, or steelhead only. Steelhead is an important species in the Klamath River during August-November when KRFC are present in the system. Thus, the river recreational fishery effort estimates were inflated to an unknown degree by steelhead fishing effort. The generalized equation for estimating river angler trips was as follow:

Total angler trips = projected adult Chinook catch ÷adult Chinook salmon catch per fishing trip (from Figure 4-3).

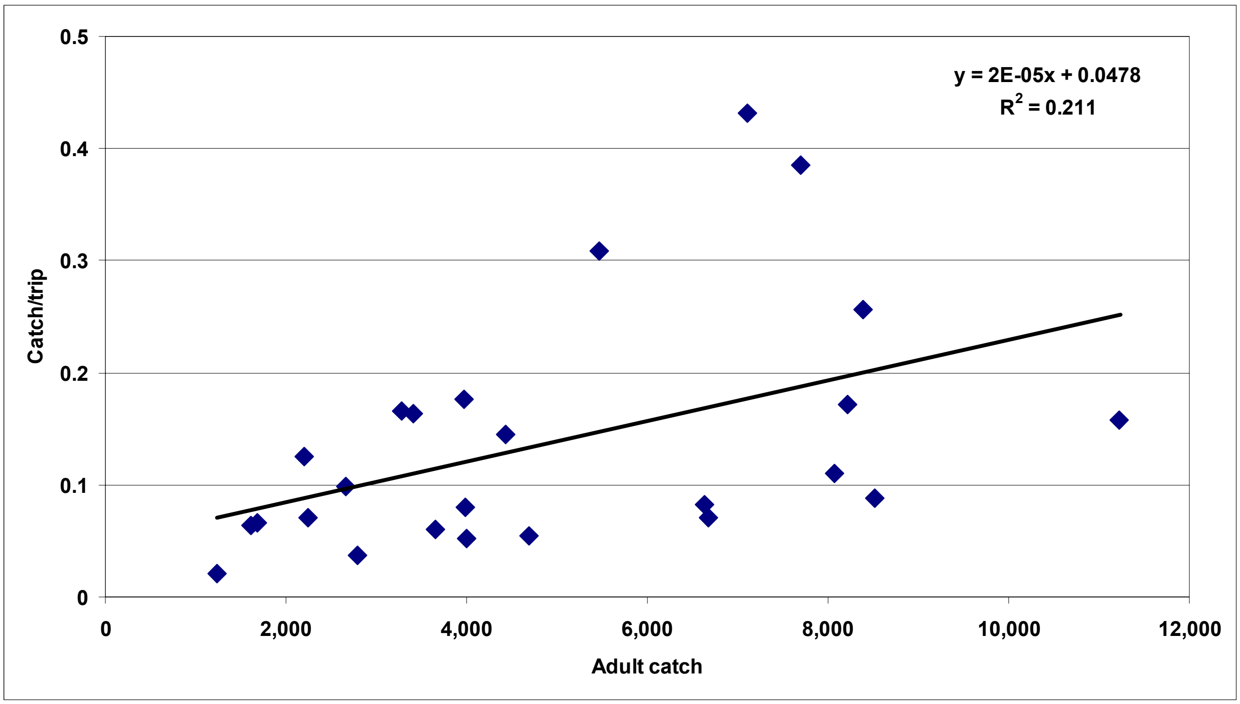

Figure 4-3. Regression of adult Chinook/trip on Lower Klamath River Chinook catch.

4.4.2 Ocean and River Fishery Economic Impacts

Economic Models

Effort estimates for the ocean recreational salmon fishery were expanded to generate estimates of community and state economic impacts for a Conservation Alert Year (CAY). Economic impact estimates for the troll fishery were for annual troll fishery revenues using recent year low and high price per pound values (ex-vessel) for 1) a CAY and 2) long-term using the SSRM. The Council's Fishery Economic Assessment Model (FEAM) was used to make community and state economic impact calculations

Ocean Recreational Fishery

Conservation Alert Year

The ocean recreational fishery analysis is based on a CAY, which under status quo does not allow ocean fisheries between Cape Falcon, Oregon and Point. Sur, California that impact KRFC. The Status Quo

Alternative shows $1 million in personal income impact to local communities and the states. The other *de minimis* fishery alternatives show economic impacts for the combined states of between $26 million for the 5% Cap Alternative to $29 million for the 13% Cap Alternative (Table 4-18). The differences in economic impact between the 5%, 10%, and 13% Cap Alternatives were entirely in the Brookings and Crescent City-Eureka areas of the KMZ because full recreational fishing seasons were assumed outside the KMZ under these alternatives. The economic impact difference between the alternatives for the KMZ recreational fishery, not including the Status Quo Alternative, ranged from $812 ,000for the 5% Cap Alternative to about $3.2 million for the 13% Cap Alternative (Table 4-18), a difference of nearly $2.4 million

Table 4-18. Ocean recreational fishery local and state income impacts (000s) of *de minimis* fishery alternatives applied to a Conservation Alert year by port area and state. [a/]

	Oregon					California						
Alternative	Tillamook/ Newport	Coos Bay	Brookings	Coastal Community Total	State Total	Crescent City/ Eureka	Fort Bragg	San Francisco	Monterey	Coastal Community Total	State Total	Oregon and California Totals
Status Quo	$7	$5	$0	$12	$16	$0	$120	$770	$26	$916	$1,001	$1,017
5%	$2,323	$1,627	$383	$4,333	$5,602	$459	$2,100	$10,749	$3,989	$17,298	$19,994	$25,597
10%	$2,323	$1,627	$906	$4,855	$6,325	$1,503	$2,100	$10,749	$3,989	$18,342	$21,396	$27,721
13%	$2,323	$1,627	$1,221	$5,171	$6,761	$2,025	$2,100	$10,749	$3,989	$18,864	$22,097	$28,858
Range (1990-2005)	$381-$6,652	$21-$3,780	$550-$2,310	$1,250-$14,490	$1,540-$17,060	$545-$4,540	$630-$2,400	$7,270-$15,840	$2,100-$14,030	$11,290-$33,026	$13,040-$39,620	$14,580-$56,680

a/ This is a year when the projected natural escapement of KRFC is <35,000 adult fish in the absence of fishing. All September-December recreational fisheries would be subject to closure in a Conservation Alert Year except: Fort Bragg and Monterey in September-October and San Francisco in October-November (STT 2006).

Long-term Analysis

A long-term analysis was not done for the ocean recreational salmon fishery. The ocean recreational salmon fishery is not expected to be substantially affected by future abundance levels of KRFC except in CAYs, which are analyzed in the previous section. The ocean recreational salmon fishery outside of the KMZ has a small impact on KRFC with full fishing seasons compared to the troll fishery and the KMZ recreational fishery as shown in Table 4-17. Recent years' ocean recreational salmon fishery data show an average annual economic impact for the two states of about $44 million annually (Table 3-2).

Ocean Troll Fishery

Annual troll fishery catch was estimated for each alternative based on effort output (troll fishing days) from the KOHM for the troll fishery regulation scenarios shown in Table 4-15. Troll fishery effort data were expanded to estimate total Chinook salmon catch based on Chinook salmon catch per troll fishing day and average weight of troll-caught Chinook salmon data available in the annual Review of Ocean Salmon Fisheries. The catch per troll fishing day data were categorized into low, medium and high troll fishing success categories based on 1991-2004 data to show the range in catches that might be expected under the respective alternatives. Long-term impacts of the *de minimis* fishing alternatives, based on a range of assumptions regarding the ex-vessel price of troll-caught Chinook, are shown in Appendix H. The formula used to estimate long-term impacts of the *de minimis* fishery alternatives and data on the effect of ex-vessel price on troll-caught Chinook salmon revenues were presented in Appendix J. Troll fishery ex-vessel prices for 2005 were used to estimate impact of the alternatives in a CAY and an average long-term year.

Conservation Alert Year

The Status Quo Alternative provides no troll fishing during January-August between Cape Falcon, Oregon, and Point Sur, California in a CAY. The CAY analysis shows a range in local and state personal income economic impacts using 2005 average prices of from zero dollars under the Status Quo Alternative to nearly $26.8 million for the 13% Cap Alternative and the high fishing success rate scenario. Based on the low fishing success rate scenario, the range was from zero economic impact to about $8.7 million in sate level impacts. Most of the troll fishery benefits accrue to the California fishery (Table 4-19).

An analysis of port dependence on troll salmon fishing (Appendix K) showed that ports with the largest troll salmon fleets (>50 vessels) during 2003-2005 were Moss Landing, Princeton, San Francisco, Bodega Bay, Fort Bragg, Coos Bay, Newport, and Tillamook. The ports with the greatest dependence on salmon as a proportion of total fishery catch (>50% of ex-vessel value) were Santa Cruz, Bodega Bay, and Fort Bragg. The ports with average ex-vessel revenues exceeding $1 million annually were Moss Landing, Princeton, San Francisco, Bodega Bay, Fort Bragg, Coos Bay, and Newport. Generally, salmon troll was second to Dungeness crab as the most important commercial species to most boats and ports. Of 1,068 vessels landing commercial fish species in Oregon and California during 2003-2005, 40% fished for salmon only and 60% fished for two or more species. The multi-species salmon vessels averaged $25,200 per year for salmon (36%) compared to $30,500 (43%) for crab, and $14,900 (21%) for all other species. The projected number of vessels landing salmon under the *de minimis* fishing alternatives with a medium success rate scenario by port indicated the alternatives would have a major impact on the number of vessels expected to participate in the troll salmon fishery (Table 4-20). Only 268 boats participated under the 5% Cap Alternative and 354 under the 13% Cap Alternative. This compares to a fleet average of 906 during 2003-2005.

Table 4-19. Troll fishery local and state income impacts ($ 000s) for the Council's *de minimis* fishery alternatives for a Conservation Alert year and average long-term year by state, port area, and troller success rate category.

	Oregon					California						Combined
Alternative/ success rate category[a/]	Tillamook/ Newport	Coos Bay	Brookings	Coastal Community Total	State Total	Crescent City/ Eureka	Fort Bragg	San Francisco	Monterey	Coastal Community Total	State Total	Oregon and California Totals
Conservation Alert Year[b/]												
SQ Low	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Med	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
High	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
5% Low	$1,479	$127	$0	$1,606	$1,701	$0	$0	$1,667	$971	$2,638	$2,757	$4,457
Medium	$3,078	$346	$0	$3,424	$3,626	$0	$0	$2,608	$1,771	$4,379	$4,576	$8,202
High	$5,002	$501	$0	$5,503	$5,829	$0	$0	$4,165	$3,043	$7,207	$7,532	$13,361
10% Low	$1,491	$276	$0	$1,767	$1,871	$0	$0	$1,667	$3,712	$5,379	$5,622	$7,493
Med	$3,103	$754	$0	$3,857	$4,085	$0	$0	$2,608	$6,773	$9,381	$9,804	$13,889
High	$5,042	$1,094	$0	$6,136	$6,498	$0	$0	$4,165	$11,636	$15,800	$16,513	$23,012
13% Low	$1,715	$353	$0	$2,068	$2,190	$0	$0	$1,667	$4,524	$6,191	$6,470	$8,660
Med	$3,569	$963	$0	$4,532	$4,800	$0	$0	$2,608	$8,254	$10,862	$11,352	$16,152
High	$5,799	$1,398	$0	$7,197	$7,622	$0	$0	$4,165	$14,180	$18,345	$19,172	$26,794
Long-term Average Year[c/]												
SQ Low	$1,604	$384	$0	$1,988	$2,107	$0	$0	$1,327	$3,349	$4,676	$4,884	$6,991
Med	$3,337	$1,050	$0	$4,387	$4,650	$0	$0	$2,076	$6,111	$8,187	$8,551	$13,201
High	$5,423	$1,523	$0	$6,946	$7,363	$0	$0	$3,315	$10,498	$13,813	$14,427	$21,789
5% Low	$1,918	$412	$0	$2,331	$2,471	$0	$0	$1,611	$3,538	$5,149	$5,378	$7,848
Medium	$3,992	$1,126	$0	$5,118	$5,425	$0	$0	$2,521	$6,455	$8,976	$9,374	$14,800
High	$6,488	$1,633	$0	$8,121	$8,608	$0	$0	$4,026	$11,089	$15,115	$15,786	$24,394
10% Low	$1,941	$467	$0	$2,408	$2,552	$0	$0	$1,616	$4,450	$6,066	$6,336	$8,888
Med	$4,039	$1,275	$0	$5,314	$5,633	$0	$0	$2,528	$8,121	$10,649	$11,121	$16,754
High	$6,564	$1,849	$0	$8,413	$8,918	$0	$0	$4,037	$13,951	$17,988	$18,786	$27,704
13% Low	$2,064	$512	$0	$2,576	$2,730	$0	$0	$1,667	$5,036	$6,702	$7,000	$9,730
Med	$4,294	$1,399	$0	$5,693	$6,034	$0	$0	$2,608	$9,188	$11,796	$12,320	$18,354
High	$6,978	$2,029	$0	$9,007	$9,547	$0	$0	$4,165	$15,784	$19,949	$20,835	$30,382
Range (1990-2005	$860-$2,450	$200-$8,180	$31-$1,250	$1,250-$13,550	$1,740-$18,300	$0-$2,040	$120-$13,020	$5,650-$2,080	$1,980-$12,150	$8,790-$33,030	$9,230-$36,670	$15,030-$54,980

a/ Low, medium and high refer to years of low, medium and high troll fishery success rate during 1991-2004 measured as Chinook salmon catch per troll fishing day.

b/ This is a year when the projected natural escapement of KRFC is < 35,000 adult fish in the absence of fishing. Values are for January-August fisheries only. Monterey would be the only September-December fishery not subject to closure (STT 2006).

c/ Based on the stock recruitment simulation model.

Table 4-20. Number of vessels projected to participate in the troll salmon fishery by port area and alternative (medium success rate assumption).

Period/Alternative	Monterey	San Francisco	Central Oregon	Northern Oregon	Totals
03-05 avg	164	310	211	221	906
94-05 avg	221	391	159	209	980
Status Quo	0	0	0	0	0
5% Cap	61	85	21	101	268
10% Cap	108	85	31	103	327
13% Cap	123	85	35	111	354

Long-term Analysis

The differences in economic impact of the alternatives was much narrower based on the long-term analysis with annual economic impacts ranging from $ 7.0 million for the Status Quo Alternative to $ 9.7 million under the 13% Cap Alternative for the low success rate scenario. Under the high success rate scenario the range in values was from $21.8 million under the Status Quo Alternative to $30.4 million under the 13% Cap Alternative. Most of the troll fishery benefits accrue to the California fishery (Table 4-19). The relatively small differences in the alternatives in this analysis compared to the CAY analysis were due to low frequency of *de minimis* fishery events over the 40-time span used on the SSRM samples.

4.4.3. Klamath River Fishery Economic Impacts

Tribal fishery

The river tribal commercial fishery economic impacts were estimated based on tribal commercial fishery data (Yurok Tribe 2006).

Conservation Alert Year

The Klamath River tribal fisheries were not expected to harvest a significant number of KRFC in a CAY if all non-tribal fisheries were regulated to have no impact on the stock. Under the other alternatives the tribal fishery harvest increased from about 4,700 fish under the 5% Cap Alternative to about 11,000 fish under the 13% Cap Alternative (Table 4-17). The small number of fish available for tribal harvest under all of the alternatives resulted from low ocean abundance of KRFC used for this analysis. The minimum subsistence need of the tribes was assumed to be 12,000-16,000 fish, thus none of the alternatives were expected to provide for commercial fishing opportunity in a CAY

Long-term Analysis

A variety of tribal fishing opportunities were evaluated for each of the *de minimis* fishing alternatives. These included average annual catch, proportion of years with commercial fishing opportunity, average annual commercial catch, and value of the commercial catch. In all comparisons, the Status Quo Alternative had slightly greater benefit to the tribal fisheries than any of the *de minimis* fishery alternatives (Table 4-21).

Table 4-21. Tribal fishing opportunities under *de minimis* fishing alternatives based on SSRM results (see Appendix H for catch frequencies).

	Alternative			
Opportunity Description	Status Quo	5% Cap	10% Cap	13% Cap
Average annual catch	48,834	48,798	48,589	48,313
Annual catch as proportion of Status Quo	1.00	1.00	0.99	0.99
Proportion of years with minimum subsistence catch[a/]	0.76	0.76	0.75	0.75
Proportion of years with commercial opportunity[b/]	0.72	0.71	0.71	0.70
Average annual commercial catch	32,834	32,798	32,589	32,313
Average commercial catch as proportion of Status Quo.	1.00	1.00	0.99	0.98
Commercial value ($,000s)[c/]	$1,477.5	$1,475.9	$1,466.5	$1,454.1
Commercial value as proportion of Status Quo.	1.00	1.00	0.99	0.98

a/ Proportion of years meeting minimum subsistence need is based on annual catch >12,000.

b/ Proportion of years with commercial opportunity is based on annual 16,000 fish subsistence need.

c/ Commercial value is based on Yurok tribal information showing each commercial fish is worth $45 in fisherman income (Yurok Tribe 2006).

River Recreational Fishery

Long-term river recreational expenditures were estimated using harvest output from the SSRM model.

These harvest estimates were converted to trips using creel survey data and the regression relationship in Figure 4-3. Total trip expenditures were estimated based on results of a 2004 angler survey showing average expenditures per Klamath River salmon trip of $66.67 (Thomson, in review).

Conservation Alert Year

The Klamath River recreational fisheries were not expected to harvest any KRFC in a CAY if tribal and all other non-tribal fisheries were regulated to have no impact on the stock. The catch increased from about 700 fish under the 5% Cap Alternative to about 1,700 fish under the 13% Cap Alternative. The effort levels associated with these catch levels increased from 11,400 angler days under the 5% Cap Alternative to 20,500 days under the 13% Cap Alternative. A corresponding increase in angler expenditures associated with the alternatives ranged from $760,000for the 5% Cap Alternative to $1.4 million for the 13% Cap Alternative (Table 4-22).

Table 4-22. River recreational fishery catch, effort and expenditures associated with *de minimis* fishing alternatives for a Conservation Alert Year.

	Alternative			
	Status Quo	5% Cap	10% Cap	13% Cap
Catch	0	706	1,287	1,655
Effort[a/]	0	11402	17501	20457
Economic Impact (000s) [b/]	$0	$760	$1,167	$1,364

a/ Based on the effort regression equation in Figure 4-4.
b/ Based on $66.67 Per angler trip

Long-term Analysis

The SSRM outputs for the river recreational Chinook salmon fishery indicated all alternatives were within 45 fish in terms of average annual catch. The proportion of years when a maximum catch of more than 12,000 adult Chinook salmon was likely to occur were also very similar for all alternatives, as were trends in angler effort and economic impact. (Table 4-23).

Table 4-23. Klamath River recreational fishing opportunity and angler expenditure estimates under *de minimis* fishing alternatives based on SSRM results (see Appendix H for catch frequencies).

	Alternative			
Opportunity Description	Status Quo	5% Cap	10% Cap	13% Cap
Average annual catch	12,071	12,081	12,063	12,036
Average catch as proportion of Status Quo	1.00	1.00	1.00	1.00
Proportion of years with maximum catch likely[a/]	0.55	0.55	0.54	0.53
Angler effort[b/]	41,736	41,742	41,732	41,716
Economic impact (000s)	$2,782.6	$2,782.9	$2,782.3	$2,781.2
Economic impact as proportion of status quo.	1.00	1.00	1.00	1.00

a/ Proportion of years with maximum catch is based on a 12,000 adult Chinook salmon quota.
b/ Based on average annual catch and Figure 4-3 regression.

4.5 Analyses of Alternatives Relative to Biological and Economic Criteria

Thorough scoping of the EA process should focus on those environmental components likely to be affected by the proposed action. NAO 216-6 Section 6.02 guidelines were followed in Section 1.5 in reviewing relevant environmental conditions as they relate to findings made in previous environmental documents. This screening process considered a variety of environmental components and the conclusion reached was that the proposed action will not have a significant impact on those components, and that those components can be eliminated from further consideration. The geographic scope of KRFC impacts in ocean fisheries was limited to the area between Cape Falcon, Oregon and Point Sur, California, as observed tag recoveries were rare outside this area and therefore constraints on fisheries outside this area would provide no measurable benefit to KRFC. Because KRFC was considered a weak stock within the Salmon FMU for the purpose of this amendment, impacts from the proposed action on other stocks in the

Cape Falcon to Point Sur ocean fishing area were removed from consideration and the assessment limited to KRFC.

The objective of this amendment is to allow fisheries to occur during temporary periods of depressed KRFC status without jeopardizing the long term productivity of KRFC. Two approaches were used to compare impacts of the alternatives on natural spawning escapement of KRFC:

1. Analysis of previous years' pre-season ocean abundance estimates (Hindcast Analysis, Section 4.2); and
2. Development and application of a population simulation model, (Stock Stochastic Simulation Model, SSRM, Section 4.3).

Both the Hindcast and SSRM analyses provided estimates of fishery impacts of the alternatives using means of sample data for 40-year time frames in calculating the probabilities of certain population events occurring, however, the SSRM also estimated short-term (1-5 years) and long-term (up to 40 years) probabilities. These events, which were used as evaluation criteria as described in Section 1.5; had no established critical levels on which to test for significance. The exception was the ESA consultation standard, which had a specified criterion of less than a 50% probability of exceeding a 17% ocean impact rate (16% ocean harvest rate) on age-4 KRFC in any one year. Therefore, the relative impacts of the alternatives were compared with impacts of the Status Quo Alternative. There were important differences in the two analytical approaches, which are described in the following:

Hindcast Analysis The Hindcast Analysis used actual age-specific pre-season stock abundance data to project natural spawning escapement under each of the alternatives. The analysis was "static" in that the effect of added fishing mortality under the *de minimis* alternatives resulted in reduced ocean abundance of non-maturing fish (age-3 and age-4 fish to become age-4 and age-5) and did not adjust for recruitment effect stemming from reduced natural spawner abundance. However, the carry-over analysis presented in Appendix F demonstrated that reduced ocean abundance of non-maturing fish had a relatively minor impact on ocean and natural spawner abundance levels. Recruitment effect was not analyzed, but likely would have shown reduced recruitment of age-3 fish following years in which *de minimis* fisheries occurred. Thus, the Hindcast results are "optimistic" in that recruitment effect would have shown lower ocean population levels and escapements than those estimated for the *de minimis* fishing alternatives. The Hindcast Analysis also used pre-season KOHM abundance estimates, which varied considerably from the post-season estimates as shown in Figure 4-2. The data in Table 4-12 show that the pre-season projections during 1988-2005 were, on average, 29% higher than the post-season estimates. Thus, the Hindcast Analysis is again "optimistic" in terms of natural spawning escapement resulting from the *de minimis* fishing alternatives. Corrections for the bias observed in the historical preseason vs. .postseason abundance estimates were made in the KOHM as specific issues were identified, the most recent correction being made in 2006. As a result of these corrections, future preseason forecasts should be less biased, and therefore the Hindcast Analysis may not accurately reflect future uncertainty in the probabilities of population events.

SSRM: The SSRM was a theoretical model; actual population data were only used to start the model iterations. The model used available data on KRFC fishery and population parameters and applied a Ricker stock recruitment model to projectage-3 ocean recruits. Prager and Mohr (1999) indicated the available stock and recruitment data appeared to follow the dome-shaped Ricker curve, but there were wide deviations between the data points and the fitted curve. This resulted in low confidence in the projections of ocean abundance of age-3 recruits. There was also considerable error in the various estimates used to project other critical population parameters and ocean and river fishery effects on the natural and hatchery spawning runs. The sources of error in the estimates were discussed in Section 4.3.1. Estimates of management error were included in the projections of age-3 ocean recruits and the effect of ocean fisheries on river run size and natural and hatchery spawning escapements. Efforts were made to calibrate the model to produce average annual population and fishery catches consistent with the range of recent years' fishery and population estimates. The differences between alternatives in the SSRM projections were not always clear, in part because of the relatively large measurement error in the model calculations, which in many ways reflects the reality of the current management (and management of other Pacific salmon stocks in general).

4.5.1 Biological Components

Probability of a Natural Spawning Escapement Lower Than Historically Observed

Hindcast Analysis

None of the alternatives, including the Status Quo Alternative, resulted in preseason predictions of less than 12,000 natural spawners in any one year in the Hindcast Analysis (Table 4-24). This was because none of the pre-season projections used in the analysis had a natural escapement below 12,000 adult spawners in any year (Table 4-4). Because of management uncertainty, escapements of approximately 12,000 natural spawners occurred in 1991 and 1992

SSRM Analysis

The SSRM 40 year simulation period projections of naturally spawning escapements less than 12,000 ranged from 1% to 3% for the 5% Cap and 13% Cap alternatives, respectively, compared to the Status Quo Alternative probability of 1%. The historical proportion of years with Klamath Basin natural escapement <12,000 fall run adults was 6% (1 in 17 years) (Table 4-24). The risk of natural escapements less than 12,000 increased fairly linearly, indicating there was no compounding effect as higher *de minimis* fishing rates were allowed (Figure 4-4).

Table 4-24. Comparison of alternatives relative to evaluation criteria and historical data.

Impact Criterion	Method	Alternative: Status Quo	Alternative: 5% Cap	Alternative: 10% Cap	Alternative: 13% Cap	Historical Average
Biological Criteria						
Probability of a natural spawning escapement lower than any historically observed (12,000)	SSRM[a/]	1%	1%	2%	3%	6%
Probability of any of the major mid-Klamath Basin substocks having a natural spawning escapement of less than 720 adults in any year.	SSRM	15%	16%	18%	19%	35%
Probability of a spawning escapement below the 35,000 natural spawner floor in any year.	Hindcast[b/]	9%	13%	31%	31%	47%
	SSRM	27%	28%	30%	32%	47%
Probability of three consecutive years of spawning escapement less than the 35,000 floor within a 40-year time period.	Hindcast	3%	3%	59%	58%	100%
	SSRM	70%	74%	79%	82%	100%
Probability that hatchery egg collection goals will be met every year.	SSRM	70%	70%	70%	69%	NA
ESA Consultation Standard						
CCC salmon (probability of exceeding Klamath fall Chinook Age-4 ocean harvest rate standard of	SSRM	39%	39%	40%	44%	50%
Socio-Economic Criteria						
Ocean recreational fishery local impacts ($ millions)	KOHM/FEAM-CAY[c/d/e/]	$ 1.0	$ 25.6	$ 27.7	$ 28.9	$ 26.4
Troll fishery local and state impacts ($ millions)	KOHM/FEAM-CAY[f/]	$ 0	$ 8.2	$ 13.9	$16.2	NA
	SSRM/FEAM-long-term[f/g/]	$ 13.2	$ 14.8	$ 16.8	$ 18.4	$ 37.6
Tribal fishery subsistence need (proportion of years)[h/]	KOHM-CAY	0%	0%	0%	0%	0%
	SSRM-long term	76%	76%	75%	75%	58%
Tribal fishery economic impact ($ millions)[i/]	KOHM-CAY	$0	$0	$0	$0	$0
	SSRM-long term	$1.5	$1.5	$1.5	$1.5	$0.9
Klamath River recreational fishery economic expenditures ($ millions)	KOHM-CAY	$0.0	$0.8	$1.2	$1.4	NA
	SSRM-long-term	$2.8	$2.8	$2.8	$2.8	NA

a/ SSRM = stochastic stock recruitment model. All probabilities reflect long-term risk (40 year simulation period).
b/ Analysis of 1985-2006 pre-season stock abundance data .
c/ KOHM = Klamath Ocean Harvet Model.
d/ FEAM = Fishery Economic Assesssment Model.
e/ CAY = Conservation Alert Year (<35K natural spawners projected).
f/ Medium success rate scenario used.
g/ Long-term analysis is 40-years.
h/ Minimum tribal subsistence need assumption was 12,000 adult KRFC.
i/ Assumes each fish is worth $45 to tribal fisherman.

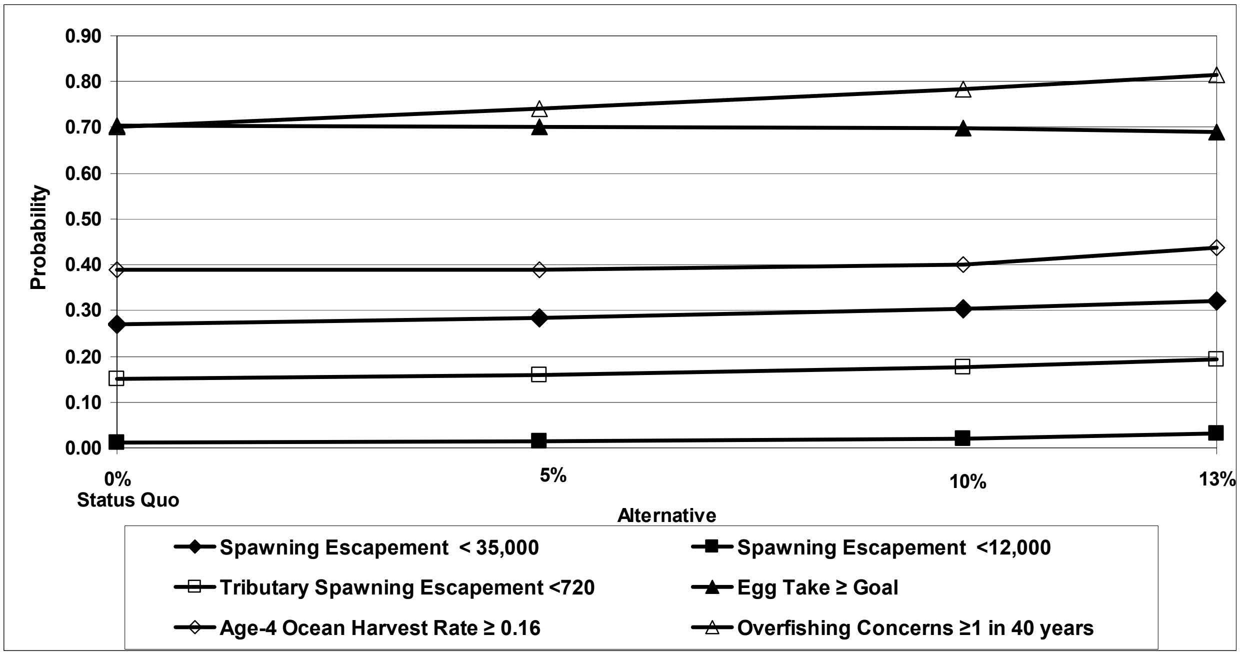

Figure 4-4. Probability of key population events under *de minimis* fishing alternatives based on 40 year SSRM simulations.

The five-year simulation period risks were approximately twice the 40-year simulation period risks because the initial status of KRFC used in the SSRM was depressed (Table 4-13). There was increased risk of a natural escapement of <12,000 adults as the fishing level increased, ranging from 2% for the Status Quo Alternative to 6% for the 13% Cap Alternative (Figure 4-5).

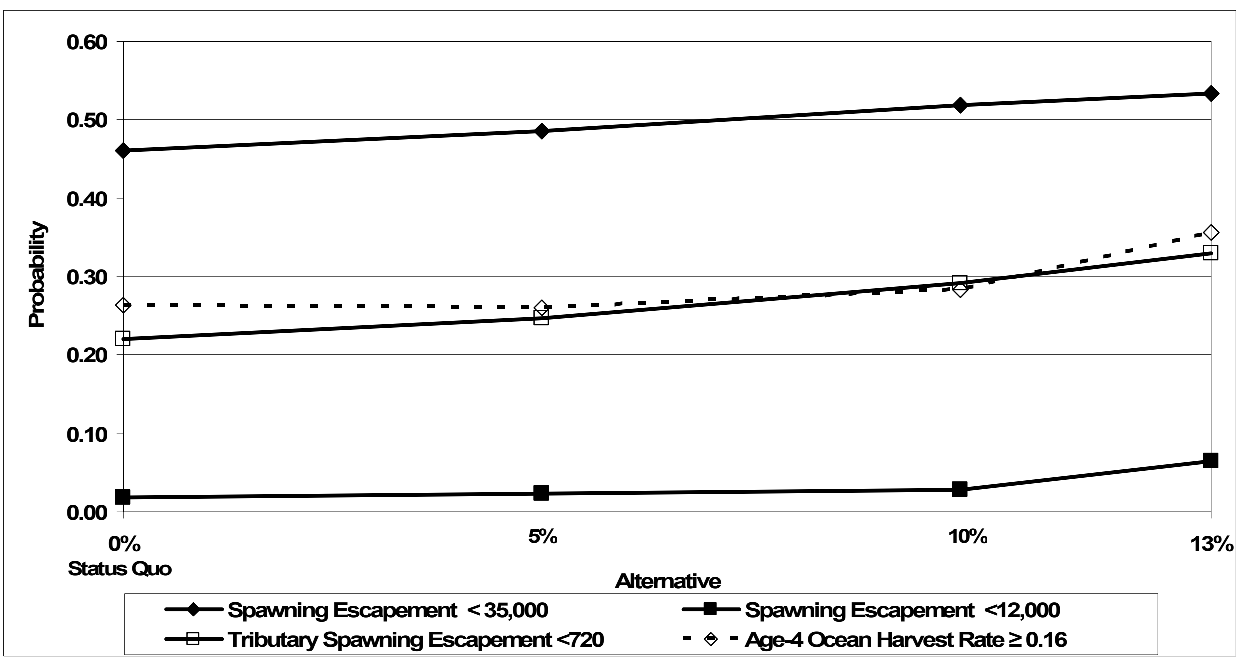

Figure 4-5. Probability of key population events under *de minimis* fishing alternatives in years 1 to 5 of SSRM simulations.

Probability of a Major Mid-Klamath Basin Substock (Shasta, Scott, or Salmon Rivers) Having a Natural Spawning Escapement of Less Than 720 Adults

SSRM Analysis

A statistical model was developed to estimate the probability of any mid-Klamath Basin natural spawning run falling below 720 adult fish in any year for any given total Basin natural run size (Appendix D). This relationship was used in the SSRM to estimate the probability of one of the mid-Basin natural runs falling below 720 adults for each of the alternatives. The long-term probability of a tributary natural spawning escapement of less than 720 in any year increased steadily from 15% under the Status Quo Alternative to 19% under the 13% Cap Alternative. The historical data indicated 35% of years (6 in 17) with < 720 adult spawners in one or more of these streams (Table 4-24; Figure 4-4).

The short term risk of spawning escapement less than 720 adults in the mid-Klamath tributaries was greater than the long term risk, as expected, ranging from 22% for the Status Quo Alternative to 33% for the 13% Cap Alternative (Table 4-13). However, short-term risks have long-term implications because loss of genetic diversity can potentially affect long-term productivity of the stock. The rate of risk increased fairly steadily as the *de minimis* fishery impact increased, indicating minimal compounding effects (Figure 4-5).

Probability of a Spawning Escapement Below the 35,000 Natural Spawner Floor in Any Year.

Hindcast Analysis

This analysis showed substantial increases in probabilities of natural escapements <35,000 adults between the 5% Cap and 10% Cap alternatives (Table 4-24; Figure 4-6). The probabilities for the Status Quo and 5% Cap Alternatives were 9% and 13%, respectively. The probability for both the 10% Cap and 13% Cap Alternatives was 31%. The historical data for the Basin show 47% of years (8 in 17 years) with natural spawning escapements <35,000 adults.

SSRM Analysis

The SSRM analysis also showed an increase in probability of natural spawning escapement less than 35,000 adults between the alternatives, but the relative differences were small compared to the Hindcast Analysis (Table 4-24). The absolute difference in probability between the Status Quo Alternative and the 13% Cap Alternative was 5% for the 40- year simulation period, and 7% for the 5--year simulation period. The risk of escapements less than 35,000 also increased fairly linearly for both simulation periods, indicating there was no compounding effect as higher *de minimis* fishing rates were allowed. The historical data for the Basin show 47% of years (8 in 17 years) with natural spawning escapements <35,000 adults.(Table 4-13; Figures 4-4 and 4-5).

The major differences between the SSRM and Hindcast Analyses were for the Status Quo and 5% Cap Alternatives, which had much lower probabilities in the Hindcast Analysis (Table 4-24; Figures 4-4 and 4-6). This was due, in part, to the use of pre-season estimates in the Hindcast Analysis as opposed to the post-season projections in the SSRM. As previously noted, pre-season estimates were generally higher than post-season estimates for years since 1985.

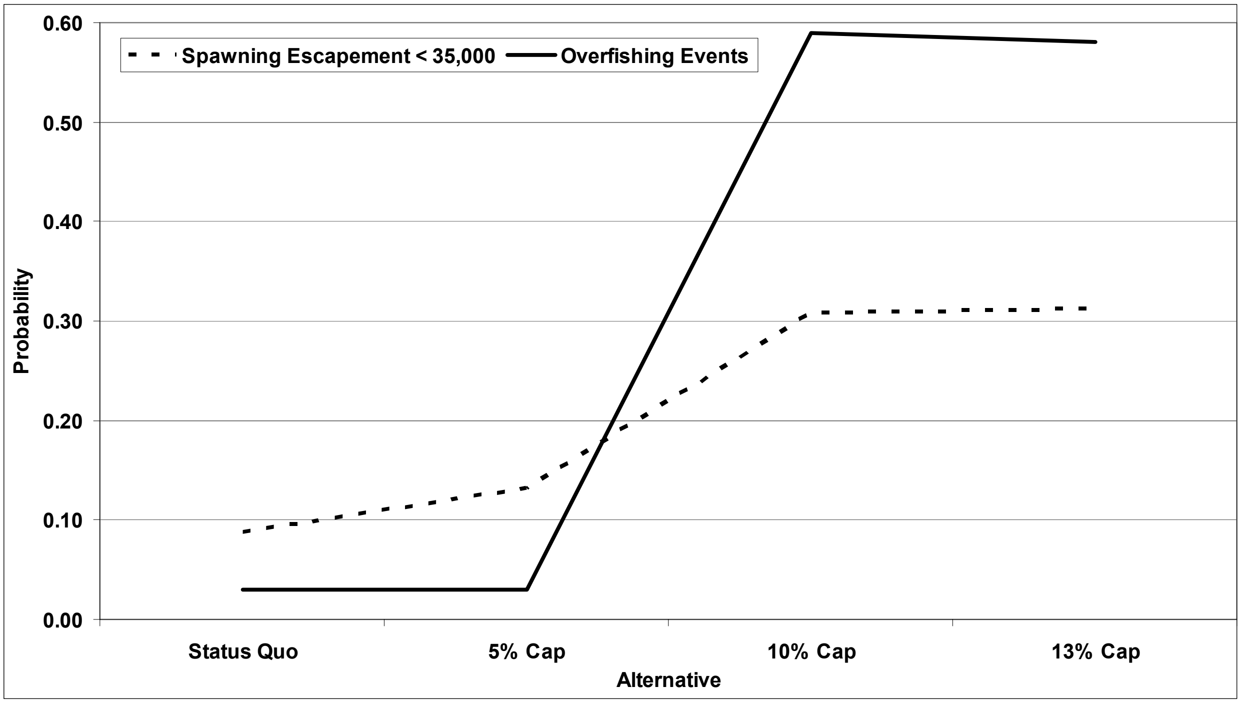

Figure 4-6. Probability of key population events under *de minimis* fishing alternatives in 40 year bootstrap samples from the Hindcast Analysis.

Probability of Three Consecutive Years of Spawning Escapement Less Than the 35,000 Floor Within a 40-Year Time Period

Hindcast Analysis

The Hindcast Analysis showed a substantial increase in probability of Overfishing Concerns (three consecutive years of natural escapement less than 35,000 natural adult spawners) with increasing *de minimis* fishing levels. The probabilities were similar for the Status Quo and 5% Cap Alternatives at 3% each, but increased to nearly 60% for the 10% and 13% Cap Alternatives. Historically there was one Overfishing Concern in 17 years (100%; Table 4-24; Figure 4-6).

SSRM Analysis

The SSRM analysis also showed an increase in probability of Overfishing Concerns with increasing *de minimis* fishing rates, and while the range of absolute differences among the alternatives was only 12%, the overall probabilities were higher (> 70%) than for the Hindcast Alternative (Table 4-24). The increase in risk of overfishing increased steadily as *de minimis* fishing level increased, indicating no compounding effects (Figure 4-4).

Probability That Hatchery Egg Collection Goals Will Be Met Every Year.

SSRM Analysis

All of the alternatives had a high probability of meeting annual egg-take goals at the two Klamath Basin hatcheries, with small difference in probabilities between the alternatives (Table 4-24; Figure 4-4).

4.5.2 ESA Standards

CCC Consultation Standard: Probability of Exceeding Klamath Fall Chinook Age-4 Ocean Harvest Rate of ≤ 16.0%)

SSRM Analysis

All of the alternatives had probabilities less than 50% of exceeding the CCC ESA consultation standard of no more than a 16% ocean harvest rate on age-4 KRFC. An average of 50% of the years (3 of 6) since 2000 met the standard (Table 4-24). The absolute difference among the alternatives was 5% for the 40-year simulation period and 10% for the 5-year simulation period, and both simulation periods indicated a tendency to increase the risk between the 10% and 13% Cap Alternatives (Table 4-13; Figures 4-4 and 4-5).

4.5.3 Socio-Economic Impacts

Ocean Recreational Fishery Local Income Impacts

The ocean recreational fishery economic analysis was based on a CAY. No long-term analysis was done, in part because the only ocean recreational fishery restrictions were applied to the KMZ sport fishery, also because the ocean recreational fishery received a constant proportion of the ocean catch in the SSRM analysis, thus the long-term trend in economic impact was expected to follow the economic trend for the troll fishery, which was analyzed in the next section. KOHM effort estimates for a CAY were generated based on the regulation scenarios presented in Section 4.4 and using the FEAM to estimate community and state economic impacts. The data showed almost no economic impact for the Status Quo Alternative and between $26 and $29 million in annual economic impact for the fixed cap alternatives. These values were very close to the recent average annual economic impact estimates for the Oregon-California ocean recreational salmon fishery during 2001-2005 (Tables 3-2 and 4-24; Figure 4-7).

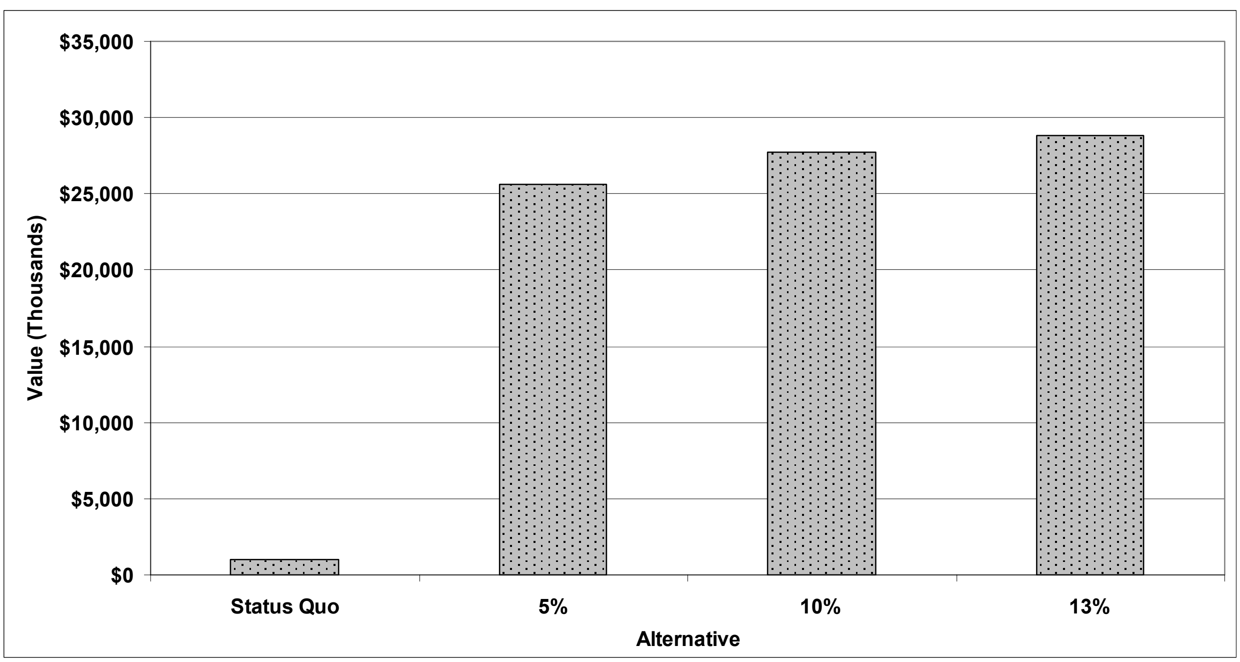

Figure 4-7. Ocean recreational salmon fishery economic impacts for a Conservation Alert Year.

Troll Fishery Local and State Level Income Impacts

Troll fishery economic impacts of the alternatives were made for a CAY based on KOHM effort estimates, historical troll fishery success rate data, and using the FEAM to estimate local and state economic impact estimates. The SSRM produced annual troll catch estimates, which were analyzed using the FEAM to produce long-term economic impact estimates. The analyses indicated major differences in the alternatives during a CAY, ranging from zero to $16 million annually in economic impact over the range of alternatives (Table 4-24; Figure 4-8). The long-term average annual economic impact increased from $13 million for the Status Quo Alternative to $18 million for the 13% Cap Alternative, a difference of about $5 million annually. The long-term economic impact projections for the fixed cap alternatives were less than half of the 2001-2005average annual troll fishery economic impact (Table 3-2; Table 4-24).

The number of vessels estimated to participate in the troll fishery in a CAY declined from 354 for the 13% Cap Alternative to 268 for the 5% Cap Alternative and zero vessels under the Status Quo Alternative. The average number of troll vessel that landed salmon during 2003-2005 was 906 (Table 4-20; Table 4-24).

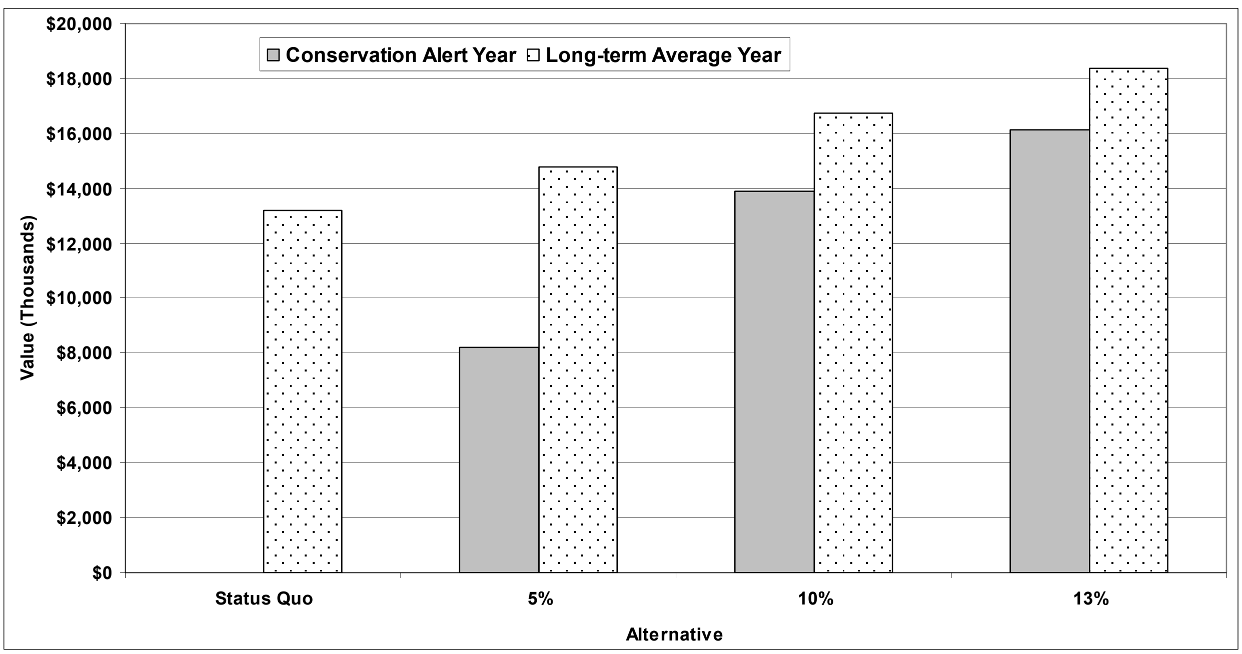

Figure 4-8. Troll fishery economic impacts for a Conservation Alert Year and the annual long-term average.

Tribal Fishery Subsistence Need

The minimum subsistence harvest need of the Yurok and Hoopa Valley tribes was assumed to be 12,000 adult KRFC. KOHM tribal catch estimates for a CAY indicated none of the alternatives would meet the minimum tribal subsistence need because of small allowable catch in ocean and river fisheries. The historical fishery data (STT 2006a) showed that tribal fishery subsistence needs were not met in CAYs (Table 4-24). The SSRM long-term projection of annual tribal catch indicated the minimal tribal subsistence need was met between 75% and 76% of the years under the alternatives. Historical data showed that Tribal subsistence needs were met in 58% of years (11 of 19 years) (Table 4-24; Figure 4-9).

Tribal Fishery Economic Impact

There likely would be no commercial fishing opportunity for the Klamath River tribes in a CAY because of the small number of fish available for tribal harvest (less than 12,000 adults). Past tribal practice indicated tribal catch in excess of about 16,000 adult fish were generally used for commercial purposes. Using the SSRM and applying an average value per fish of $45 shows an average annual long-term impact to tribal fisherman under all options of about $1.5 million. Historical Tribal commercial fishery catches have averaged about 19,300 fish per year when commercial fishing was conducted (STT 2006a) for an average annual economic impact in terms of fisherman revenues of about $869,000 (Table 4-24; Figure 4-9). Annual catch frequency data (Appendix G) showed tribal commercial fishing opportunity declined slightly between the alternatives, from about 72% under the Status Quo Alternative to about 70% under the 13% Cap Alternative. Historical data showed Tribal commercial fishing in 47% of years since 1987 (9 of 19) when detailed Tribal fishery accounting was implemented (Table 4-24; Figure 4-10).)

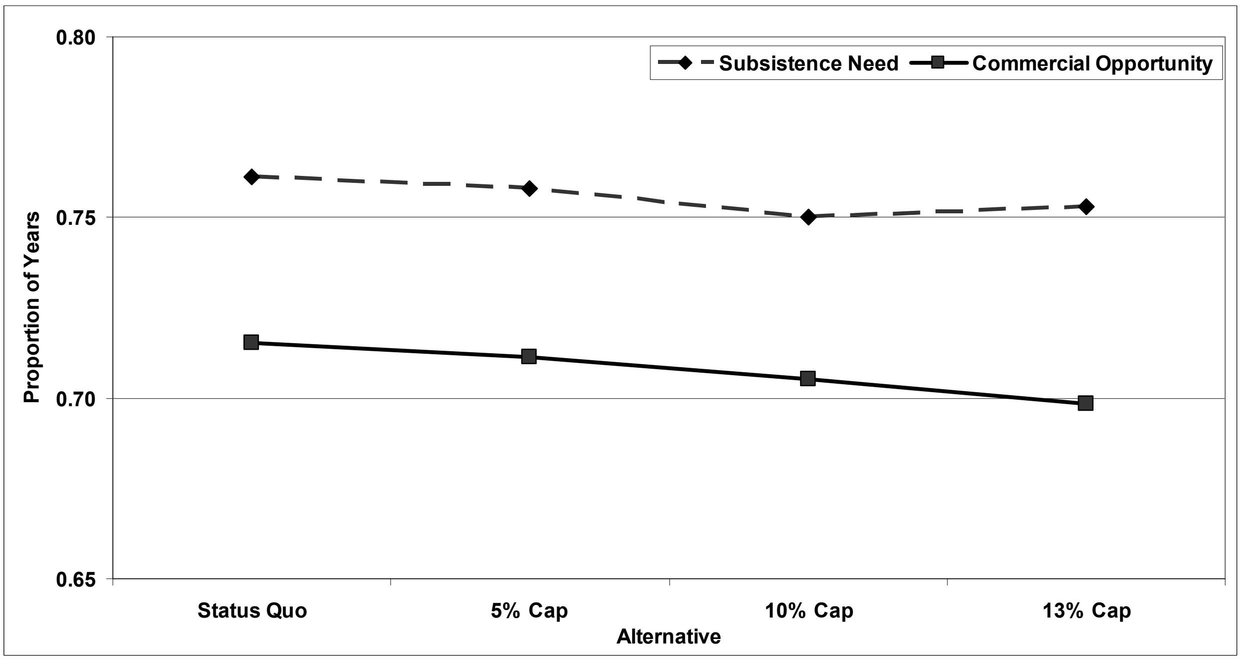

Figure 4-9. Proportion of years meeting minimum tribal subsistence needs and providing commercial opportunity.

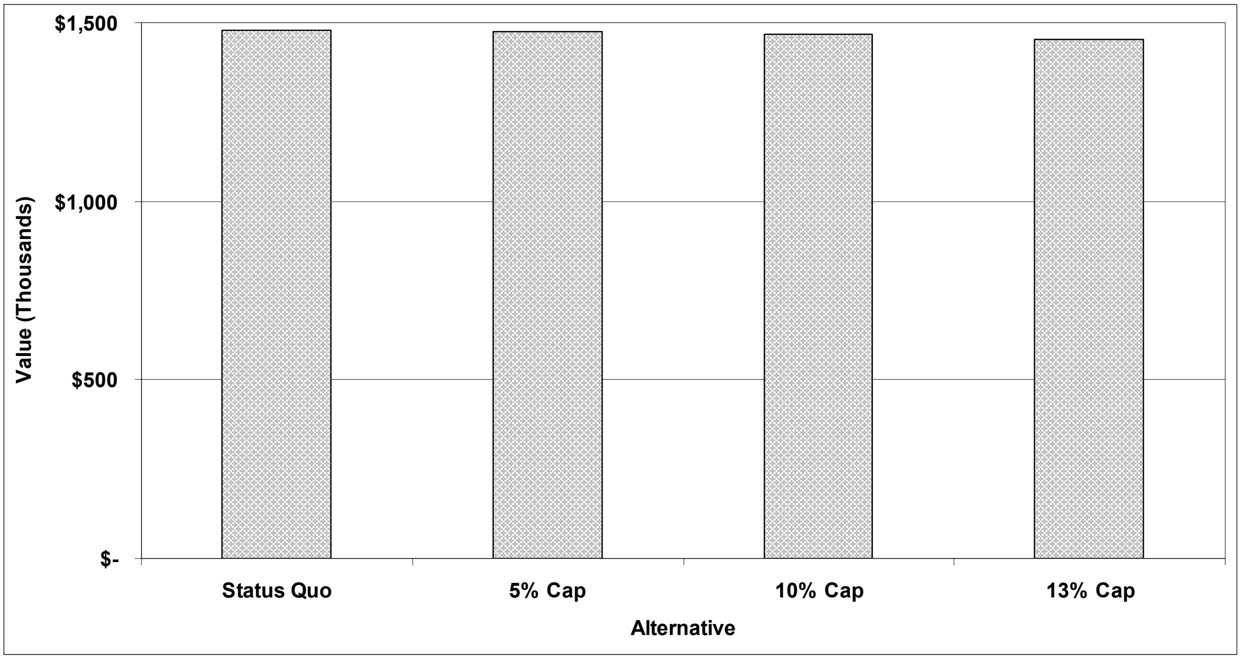

Figure 4-10. Long-term annual average economic impact of tribal commercial fishery.

River Recreational Fishery Economic Impacts

Economic impacts of the alternatives increased from zero under the Status Quo Alternative to $1.4 million under the 13% Cap Alternative in a CYA (Figure 4-11). This estimate assumed an expenditure of about $65 per angler trip and used the river recreational fishery allocation shown in Table 4-17. The long-term analysis using the SSRM indicated small differences among the alternatives with an average annual economic impact for all of the alternatives of about $2.8 million (Table 4-24; Figure 4-11).

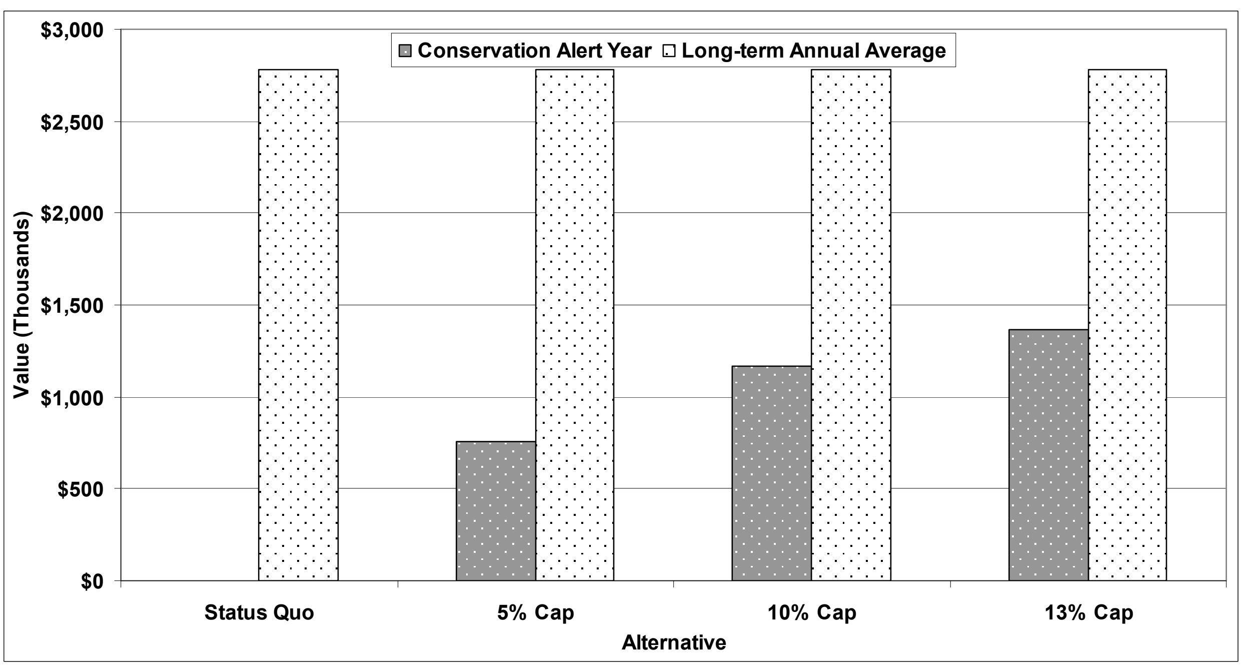

Figure 4-11. Economic impacts of alternatives on Klamath River recreational fishery in a Conservation Alert Year and the long-term annual average.

5.0 CONSISTENCY WITH OTHER APPLICABLE LAW

5.1 Magnuson-Stevens Fishery Conservation and Management Act (MFCMA)

The MFCMA provides parameters and guidance for Federal fisheries management, requiring the Councils and NMFS adhere to a broad array of policy ideals. Overarching principles for fisheries management are found in the MFCMA National Standards. In crafting fisheries management regimes, the Councils and NMFS must balance their recommendations to meet these different national standards.

5.1.1 National Standard 1

National Standard 1 requires that "Conservation and management measures shall prevent overfishing while achieving on a continuing basis, the optimum yield from each fishery for the United States fishing industry." The alternatives considered in this EA permit low levels of fishing during time of depressed stock status for KRFC, but maintain the current definition and criteria for determining when KRFC are overfished. Under the current FMP KRFC are declared overfished when the stock fails to achieve its spawning escapement floor of 35,000 natural spawners for three consecutive years (Overfishing Concern). Under the Status Quo Alternative, there is a high probability that an Overfishing Concern will occur given the productivity and natural variability of KRFC. Based on the SSRM analysis, there is a 70% probability of at least one Overfishing Concern occurring during the 40 year simulation period. The comparative probabilities for the 5% Cap, 10% Cap, and 13% Cap Alternatives are 74%, 79%, and 82%, respectively. Thus, all of the alternatives pose a high risk of overfishing the stock in future years. The Hindcast Analysis showed much lower probabilities of overfishing events for all of the alternatives, but a major increase between the Status Quo/5% Cap Alternatives and the higher impact rate alternatives. This was partly due to the use of pre-season escapement projections, which for some years was higher than the post-season estimates.

National Standard 1 requires that FMPs implemented by the Councils strike an appropriate balance between the imperative to prevent overfishing and the goal of achieving optimum yield on a continuing basis. Amendment 15 proposes a modest shift in the balance to permit low levels of fishing, as opposed to no fishing, when KRFC are depressed. The fixed cap alternatives help mitigate the severe economic consequences of a complete fishing closure and provide support for the fishing communities and infrastructure necessary to maintain a viable salmon fishing industry over the long term.

5.1.2 National Standard 2

National Standard 2 requires the use of the best available scientific information. The analyses of impacts to KRFC were based on models that have undergone review by the Council's Scientific and Statistical Committee and been approved for use by the Council. Input data are obtained from scientifically designed surveys and data recording systems administered by state, Federal, and tribal agencies, and verified during the preseason planning process by the STT. Stock forecasts are reviewed by multiagency scientific bodies to ensure accurate and appropriate methodology is used and to facilitate agreement between the relevant parties. All alternatives were subject to this same level of scientific analysis.

5.1.3 National Standard 3

National Standard 3 requires individual stocks of fish to be managed as a unit throughout their ranges and interrelated stocks of fish to be managed as a unit. The conservation objectives are established for individual stocks in the Salmon FMP and are based on either escapement or on total exploitation rate, both of which account for impacts to stocks throughout their range. All Salmon FMU stocks are interrelated, and are managed as a unit in Council-area fisheries to ensure all conservation objectives are met.

5.1.4 National Standard 4

National Standard 4 requires that "Conservation and management measures shall not discriminate between residents of different States." And that "allocation shall be: (A) fair and equitable…; (B) reasonably calculated to promote conservation; and (C) carried out in such manner that no…entity acquires an excessive share…" The assumptions used in the analyses of all alternatives were based on the range of allocations among fisheries implemented by the Council in recent years. These have all been analyzed in other NEPA documents and found to meet this standard. Although the analysis of alternatives in the EA made necessary assumptions about the distribution of KRFC impacts among fisheries, the Amendment would prescribe a new harvest rate limit, but would not otherwise limit the Council's discretion to shape fisheries consistent with National Standard 4.

5.1.5 National Standard 5

National Standard 5 requires efficiency, where practicable, in the utilization of fishery resources. The Salmon FMP currently provides for no significant ocean salmon fishing opportunity off Oregon south of Cape Falcon and California north of Point Sur during conservation alert years for KRFC. The *de minimis* fishing alternatives were intended to protect KRFC productivity while providing access to more robust stocks in the area, Sacramento River fall-run Chinook salmon in particular. Salmon fleet efficiency affects the ability of fishermen to derive an income from commercial fishing activities and to the communities that depend on fisherman. Salmon fleet efficiency declines during periods of fishery closure, when vessels are forced to fish in areas of low salmon abundance, or in areas where salmon fishing effort is already high. Salmon fishery closures can also displace fishermen into other fisheries with compounding effects. Salmon is one of several important resources for commercial fishing vessels in the Oregon and California salmon fishing area, thus the need for salmon fleet and community protection extends to other resources and fisheries as well.

5.1.6 National Standard 6

National Standard 6 requires conservation objectives and management measures to take into account and allow for variations among, and contingencies in, fisheries, fishery resources, and catches. The population viability analyses used for all alternatives were based on variation in observed parameters to estimate probabilities of specific outcomes. The alternatives considered, except for the Status Quo Alternative, address the need for contingent strategies based on resource status and economic needs of the fishery and fishery dependent communities.

5.1.7 National Standard 7

National Standard 7 requires that conservation and management measures shall, where practicable, minimize costs and avoid unnecessary duplication. The intent of this amendment is to determine an acceptable level of fishing under specific conditions, which would reduce the likelihood of requiring emergency rule implementation of annual management measures, reduce administrative costs, and require duplication of effort. All alternatives meet this standard.

5.1.8 National Standard 8

National Standard 8 requires that conservation and management measures shall, consistent with the conservation requirements of the MSA, take into account the importance of fishery resources to fishing communities in order to "(A) provide for the sustained participation of such communities, and (B) to the extent practicable, minimize adverse economic impacts on such communities." The purpose of this amendment is to provide minimal fishing opportunity as opposed to the possibility of no opportunity under certain circumstances, which would directly support sustained participation and reduce adverse economic impact to coastal fishing communities. The Alternatives considered in this EA seek a balance between the short term and the long term needs of the communities, the latter needs of which rely on long term health of the salmon stocks.

5.1.9 National Standard 9

National Standard 9 requires the reduction, to the extent practicable, of bycatch or bycatch mortality. All alternatives assume current management practices, and so there would be no increase over status quo for any bycatch and bycatch mortality rates on non-target and sublegal target species.

5.1.10 National Standard 10

National Standard 10 requires, to the extent practicable, conservation and management measures to promote the safety of human life at sea. All alternatives are consistent with Council Operating Procedure #16, Weather-related Adjustment to Salmon Fishery. All alternatives are consistent with National Standard 10.

The alternatives considered in this EA are subject to the various and sometimes contradictory elements of the National Standards. For example, obtaining the optimal yield from the West Coast salmon fishery requires access to abundant stocks, while preventing overfishing on any particular stock requires constraining that access. Therefore, a balance must be reached to address these various elements. The fishing alternatives are designed to preserve the long-term productivity of the KRFC stock, and therefore the long-term needs of the communities which depend on healthy salmon stocks, while providing for the short term survival of those communities so they can participate in future fisheries. A consequence of the fishing alternatives is some small increase in short-term risk to KRFC stock production, to provide short-term economic benefits to those communities. However, on balance the fishing alternatives are designed to provide more benefit to the nation by providing for some level of participation at the expense of slightly less economic benefit in the near future. The consequence of the Status Quo no fishing Alternative is to close the entire fishery for a period, potentially lose the infrastructure of the fishery, and then have no fishermen to participate in the fishery in the future

The risks to KRFC for this short-term economic survival are less than for most managed fish stocks. The National Standard-1 guidelines recommend a default minimum biomass threshold of no less than 50% of MSY biomass. It is worth noting that the best available estimate of the MSY escapement for KRFC is 40,700 natural spawners. This is conceptually equivalent to an MSY biomass. The spawning escapement floor used as an indicator for overfishing is 35,000, which is substantially higher than 50% of MSY biomass used as an indicator under National Standard 1. The escapement floor is therefore a conservative indicator for overfishing. For the West Coast salmon, fishery constraints are required whenever stock forecasts are below their conservation objective, which is generally set at MSY or MSP spawning escapement, or an MSY proxy. When a salmon stock is projected to fall below its MSY conservation objective, the current FMP requires closing Council area fisheries that impact that stock. This in effect ends not only overfishing, but all fishing. For KRFC, the fishing alternatives seek to allow a level of fishing consistent with rebuilding the stock to MSY levels, minimize risk to the long-term productivity of the stock, maintain the threshold for declaring the stock overfished, and provide for sustained participation of communities in the ocean salmon fishery.

5.1.11 FMP Provisions

The MFCMA lists a number of required and discretionary provisions for FMPs and amendments. Among those provisions, one is particularly applicable to this amendment, section 303(b)(9), which permits an FMP to asses and specify the effect of conservation and management measures on stocks of naturally spawning anadromous fish. The alternatives in this EA are consistent with this discretionary provision in that they specify conservation objectives for naturally spawning KRFC under certain stock status conditions and the biological effects of the alternatives were assessed using the SSRM and Hindcast Analysis.

5.1.12 EFH

The SEIS for the Salmon FMP concluded that Council-area salmon fisheries would have no significant effects on EFH. Further, NMFS conducted an EFH consultation and prepared an EFH Assessment that was incorporated into the NMFS BO on the effects of the Salmon FMP on ESA listed salmon dated April 30, 2001. The consultation concluded that the Council had adopted appropriate conservation measures related to fishing actions that occur under the Salmon FMP. The alternatives considered in this EA are within the scope of impacts considered in the SEIS and the NMFS BO, and therefore, are not expected to have any additional effects on EFH.

5.2 Consistency with the Salmon FMP

Similar to the MSA National Standards Guidelines, the goals and objectives of the Salmon FMP are intended to provide a framework to guide the Council's decisions. The fishing alternatives would allow a specified level of fishing impacts on KRFC during periods of temporary stock depression and alter the actions required under a Conservation Alert for KRFC, but would be consistent with the way many other stocks are managed under the FMP. Currently, Washington Coastal and Puget Sound stocks managed under U.S. District Court orders are permitted to have annual objectives that differ from FMP objectives if agreement of the relevant parties is reached. Therefore, if one of those stocks is projected to not meet its conservation objective in any one year, the Council is not required to close all fisheries impacting the stock. However, the threshold for declaring the stock overfished is maintained, which is failure of a stock to meet its FMP conservation objective for three consecutive years. Some FMU stocks (e.g., Oregon Coast Natural coho) are managed on an impact rate basis which permits low levels of harvest during periods of depressed stock status, while other stocks that Council area fisheries have minimal impacts on are exempted from the FMP Overfishing Criteria altogether. The impact rate basis of the fishing alternatives is consistent with these Salmon FMP management strategies.

5.3 CROSS-CUTTING MANDATES

5.3 Other Federal Laws

5.3.1 Coastal Zone Management Act

Section 307(c)(1) of the Federal Coastal Zone Management Act (CZMA) requires all Federal activities that directly affect the coastal zone be consistent with approved state coastal zone management programs to the maximum extent practicable. The Preferred Alternative would be implemented in a manner that is consistent to the maximum extent practicable with the enforceable policies of the approved coastal zone management programs of Oregon and California. This determination has been submitted to the responsible state agencies for review under section 307(c)(1) of the CZMA. The relationship of the Salmon FMP with the CZMA is discussed in Section 3.3 of the SEIS for Salmon FMP Amendment 14. The Salmon FMP has been found to be consistent with the WOC coastal zone management programs. The recommended action is consistent and within the scope of the actions contemplated under the framework FMP.

Under the CZMA, each state develops its own coastal zone management program, which is then submitted for Federal approval. This has resulted in programs which vary widely from one state to the next. None of the alternatives are expected to affect any state's coastal management program.

5.3.2 Endangered Species Act

Compliance with the ESA was addressed in Sections 1.5, 2.1, 3.2, 4.1, 4.3, and 4.5 of this EA. All alternatives would meet NMFS ESA consultation standards for listed salmon stocks.

Southern resident killer whales were listed as endangered under the ESA effective February 17, 2006. Chinook salmon have been identified as a primary prey for this population of killer whales. NMFS issued a BO dated June 6, 2006, completing Section 7 consultation on the effects of Council area salmon fisheries on southern resident killer whales and determined the anticipated Council area fisheries will not jeopardize the continued existence of the southern resident killer whale ESU. None of the alternatives were expected to significantly increase impacts to southern resident killer whales because salmon harvest impacts would be within the historical range.

The Section 7 consultations and Section 4(d) determinations have been prepared for West Coast salmon stocks by NMFS and are described in Table 5-1.

Table 5-1. NMFS' Endangered Species Act consultations and Section 4(d) determinations on ocean fisheries implemented under the Salmon FMP and their duration.

Date	Evolutionarily Significant Unit Covered and Effective Period
8-Mar-96	Snake River Chinook and sockeye (until reinitiated)
28-Apr-99	Oregon coastal coho, Southern Oregon/ Northern California coastal coho, Central California coastal coho (until reinitiated)[1/]
28-Apr-00	Central Valley spring Chinook and California coastal Chinook (until reinitiated)
27-Apr-01	Hood Canal summer chum 4(d) limit (until reinitiated)
30-Apr-01	Upper Columbia River spring Chinook and Upper Willamette River Chinook (until reinitiated)
30-Apr-01	Lower Columbia River Chinook, Upper Willamette Chinook, Upper Columbia spring Chinook, Lake Ozette sockeye, ten steelhead ESUs and Columbia River chum (until reinitiated)
27-Apr-04	Sacramento River winter Chinook (April 30, 2010)
29-Apr-04	Puget Sound and Lower Columbia River Chinook (until reinitiated)
27-Apr-06	Lower Columbia River natural coho (through April 30, 2007)

Need footnote 1/

Many of these documents are available from the NMFS Northwest Region website at: http://www.nwr.noaa.gov/1publcat/allbiops.htm

5.3.3 Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) of 1972 is the principal federal legislation that guides marine mammal species protection and conservation policy in the United States. Under the MMPA, NMFS is responsible for the management and conservation of 153 stocks of whales, dolphins, porpoise, as well as seals, sea lions, and fur seals, while the U.S. Fish and Wildlife Service is responsible for walrus, sea otters, and the West Indian manatee.

Off the West Coast, the southern resident killer whale (*Orcinus orca*), Steller sea lion (*Eumetopias jubatus*) Eastern stock, Guadalupe fur seal (*Arctocephalus townsendi*), and Southern sea otter (Enhydra *lutris*) California stock are listed as threatened under the ESA, and the sperm whale (*Physeter macrocephalus*) Washington, Oregon, and California (WOC) Stock, humpback whale (*Megaptera novaeangliae*) WOC - Mexico Stock, blue whale (*Balaenoptera musculus*) Eastern north Pacific stock, and Fin whale (*Balaenoptera physalus*) WOC Stock are listed as depleted under the MMPA. Any species listed as endangered or threatened under the ESA is automatically considered depleted under the MMPA. The West Coast ocean salmon fisheries are considered a Category III fishery, indicating a remote likelihood of or no known serious injuries or mortalities to marine mammals, in the annual list of fisheries published in the Federal Register. Based on its Category III status, the incidental take of marine mammals in the West Coast salmon fisheries does not significantly impact marine mammal stocks.

5.3.4 Migratory Bird Treaty Act

The Migratory Bird Treaty Act of 1918 was designed to end the commercial trade of migratory birds and their feathers that, by the early years of the 20th century, had diminished populations of many native bird species. The act states that it is unlawful to take, kill, or possess migratory birds and their parts (including eggs, nests, and feathers) and is a shared agreement between the United States, Canada, Japan, Mexico, and Russia to protect a common migratory bird resource. The Migratory Bird Treaty Act prohibits the directed take of seabirds, but the incidental take of seabirds does occur. None of the alternatives are likely to affect the incidental take of seabirds protected by the Migratory Bird Treaty Act.

5.3.5 Paperwork Reduction Act

The proposed action does not require collection-of-information subject to the Paperwork Reduction Act.

5.3.6 Regulatory Flexibility Act

The purpose of the Regulatory Flexibility Act (RFA) is to relieve small businesses, small organizations, and small governmental entities of burdensome regulations and record-keeping requirements. Major goals of the RFA are; (1) to increase agency awareness and understanding of the impact of their regulations on small business, (2) to require agencies communicate and explain their findings to the public, and (3) to encourage agencies to use flexibility and to provide regulatory relief to small entities. The RFA emphasizes predicting impacts on small entities as a group distinct from other entities and the consideration of alternatives that may minimize the impacts while still achieving the stated objective of the action. An initial regulatory flexibility analysis (IRFA) is conducted unless it is determined that an action will not have a "significant economic impact on a substantial number of small entities." The RFA requires that an IRFA include elements that are similar to those required by Executive Order (EO) 12866 and NEPA. Therefore, the IRFA has been combined with the Regulatory Impact Review (RIR) and NEPA analyses.

Section 5.5 (below) summarizes the analytical conclusions specific to the RFA and EO 12866.

5.4 Executive Orders

5.4.1 EO 12866 (Regulatory Planning and Review)

EO 12866, Regulatory Planning and Review, was signed on September 30, 1993, and established guidelines for promulgating new regulations and reviewing existing regulations. The EO covers a variety of regulatory policy considerations and establishes procedural requirements for analysis of the benefits and costs of regulatory actions. Section 1 of the EO deals with the regulatory philosophy and principles that were to guide agency development of regulations. It stresses that in deciding whether and how to regulate, agencies should assess all of the costs and benefits across all regulatory alternatives. Based on this analysis, NMFS should choose those approaches that maximize net benefits to society, unless a statute requires another regulatory approach.

The Regulatory Impact Review (RIR) IRFA determinations are part of the combined summary analysis in Section 5.5 of this document.

5.4.2 EO 12898 (Environmental Justice)

EO 12898 obligates federal agencies to identify and address "disproportionately high adverse human health or environmental effects of their programs, policies, and activities on minority and low-income populations in the United States" as part of any overall environmental impact analysis associated with an action. NOAA guidance, NAO 216-6, at §7.02, states that "consideration of EO 12898 should be specifically included in the NEPA documentation for decision-making purposes." Agencies should also encourage public participation—especially by affected communities—during scoping, as part of a broader strategy to address environmental justice issues.

The environmental justice analysis must first identify minority and low-income groups that live in the project area and may be affected by the action. Typically, census data are used to document the occurrence and distribution of these groups. Agencies should be cognizant of distinct cultural, social, economic, or occupational factors that could amplify the adverse effects of the proposed action. (For example, if a particular kind of fish is an important dietary component, fishery management actions affecting the availability, or price of that fish, could have a disproportionate effect.) In the case of Indian tribes, pertinent treaty or other special rights should be considered. Once communities have been identified and characterized, and potential adverse impacts of the alternatives are identified, the analysis must determine whether these impacts are disproportionate. Because of the context in which environmental justice is developed, health effects are usually considered, and three factors may be used in an evaluation: whether the effects are deemed significant, as the term is employed by NEPA; whether the rate or risk of exposure to the effect appreciably exceeds the rate for the general population or some other comparison group; and whether the group in question may be affected by cumulative or multiple sources of exposure. If disproportionately high adverse effects are identified, mitigation measures should be proposed. Community input into appropriate mitigation is encouraged.

Participation in decisions about the proposed action by communities that could experience disproportionately high and adverse impacts is another important principle of the EO. The Council offers a range of opportunities for participation by those affected by its actions and disseminates information to affected communities about its proposals and their effects through several channels. In addition to Council membership, which includes representatives from the fishing industries affected by Council action, the Salmon Advisory Subpanel (SAS), a Council advisory body, draws membership from fishing communities affected by the proposed action. While no special provisions are made for membership in the SAS to include representatives from low income and minority populations, concerns about disproportionate effects to minority and low income populations could be voiced through SAS representatives or to the Council directly. Although Council meetings are not held in isolated coastal communities for logistical reasons, they are held in different places up and down the West Coast to increase accessibility.

The Council disseminates information about issues and actions through several media. Although not specifically targeted at low income and minority populations, these materials are intended for consumption by affected populations. Materials include a newsletter, describing business conducted at Council meetings, notices for meetings of all Council bodies, and fact sheets intended for the general reader. The Council maintains a postal and electronic mailing list to disseminate this information. The Council also maintains a website (www.pcouncil.org) providing information about the Council, its meetings, and decisions taken. Most of the documents produced by the Council, including NEPA documents, can be downloaded from the website.

It should be noted that fishery participants make up a small proportion of the total population in coastal communities, and their demographic characteristics may be different from the community as a whole. However, information specific to fishery participants is not available. Furthermore, different segments of the fishery-involved population may differ demographically. For example, workers in fish processing plants may be more often from a minority population while deckhands may be more frequently low income in comparison to vessel owners. Available demographic data detailed in the SEIS show that coastal counties where fishing communities are located are variable in terms of social indicators like income, employment, and race and ethnic composition. Unfortunately, the kind of detailed population data necessary to determine the characteristics of the population affected by the proposed action are not available. However, the ports identified in Table 5-2 represent an initial screening (PFMC and NMFS 2006.

The conservation and management objectives established in the Salmon FMP, and by extension, the alternatives considered in this EA, were not expected to disproportionately affect minority and low-income communities. Generally, the Preferred Alternative is intended to maintain current fishing practices and schedules while improving Council and NMFS efficiency in implementing specifications and management measures. As a result, the Preferred Alternative is expected to have positive effects on fishing communities in general, and to have no notable negative effects on minority and low income groups in particular.

Table 5-2. Environmental Justice communities of concern. Information from PFMC and NMFS 2006.

Community	Qualifying Demographic Criteria
Oregon	
Salmon River	% Native American
Siletz Bay	% Native American
Waldport	income
Winchester Bay	income, poverty rate
Port Orford	income, poverty rate
Brookings	% Native American, income
California	
Trinidad	% Native American, income, poverty rate
Fort Bragg	% Hispanic
Albion	% Hispanic
Point Arena	% Native American, % Hispanic
Moss Landing	% Native American, % Hispanic

5.4.3 EO 13132 (Federalism)

Executive Order 13132 enumerates eight fundamental federalism principles. The first of these principles states “Federalism is rooted in the belief that issues that are not national in scope or significance are most appropriately addressed by the level of government closest to the people.” In this spirit, the Executive Order directs agencies to consider the implications of policies that may limit the scope of or preempt state’s legal authority. Preemptive action having such federalism implications is subject to a consultation process with the states; such actions should not create unfunded mandates for the states; and any final rule published must be accompanied by a federalism summary impact statement.

The Council process offers many opportunities for states and Indian tribes (through their agencies, Council appointees, advisory bodies, consultations, and meetings) to participate in the formulation of this FMP amendment. This process encourages states and tribes to institute complementary measures to manage fisheries under their jurisdiction that may affect federally managed stocks.

The proposed actions would not have federalism implications subject to Executive Order 13132.

5.4.4 EO 13175 (Consultation and Coordination with Indian Tribal Government)

EO 13175 is intended to ensure regular and meaningful consultation and collaboration with tribal officials in the development of federal policies that have tribal implications, to strengthen the United States government-to-government relationships with Indian tribes, and to reduce the imposition of unfunded mandates upon Indian tribes.

The Secretary recognizes the sovereign status and co-manager role of Indian tribes over shared federal and tribal fishery resources. At Section 302(b)(5), the Magnuson-Stevens Act reserves a seat on the Council for a representative of an Indian tribe with federally-recognized fishing rights from California, Oregon, Washington, or Idaho.

The U.S. government formally recognizes two Lower Klamath River tribes (Yurok and Hoopa Valley) have rights to fish for salmon. In general terms, the quantification of those rights is 50% of the harvestable surplus of Klamath River salmon. Both tribes have the discretion to administer their fisheries and to establish their own policies to achieve program objectives.

Klamath River tribes with Federally-recognized fishing rights may be impacted by Council-area fisheries, Accordingly, tribal allocations and regulations have been developed in consultation with the affected tribes and, insofar as possible, with tribal consensus. The Hoopa Valley Tribe and the Yurok Tribe were both represented on the Council's Ad Hoc Salmon Amendment Committee, which was responsible for development of this FMP amendment.

5.4.5 EO 13186 (Responsibilities of Federal Agencies to Protect Migratory Birds)

EO 13186 supplements the MBTA (above) by requiring federal agencies to work with the U.S. Fish and Wildlife Service to develop memoranda of agreement to conserve migratory birds. NMFS is in the process of implementing a memorandum of understanding. The protocols developed by this consultation will guide agency regulatory actions and policy decisions in order to address this conservation goal. The EO also directs agencies to evaluate the effects of their actions on migratory birds in environmental documents prepared pursuant to the NEPA, Section 1.5 in this EA evaluates impacts to seabirds and concludes that the proposed action will not significantly impact seabirds.

5.5 Regulatory Impact Review and Regulatory Flexibility Analysis

In order to comply with EO 12866 and the RFA, this document also serves as an RIR and an IRFA. A summary of these analyses is presented below.

5.5.1 EO 12866 (Regulatory Impact Review, RIR)

The regulatory principles in EO 12866 emphasize careful identification of the problem to be addressed. The agency is to identify and assess alternatives to direct regulation, including economic incentives such as user fees or marketable permits, to encourage the desired behavior. Each agency is to assess both the costs and the benefits of the intended regulation and, recognizing that some costs and benefits are difficult to quantify, propose or adopt a regulation only after reasoned determination the benefits of the intended regulation justify the costs. In reaching its decision, an agency must use the best reasonably obtainable information, including scientific, technical and economic data, about the need for and consequences of the intended regulation. The RIR provides a comprehensive review of the changes in net economic benefits to society associated with proposed regulatory actions. The analysis also provides a review of the problems and policy objectives prompting the regulatory proposals and an evaluation of the major alternatives that could be used to solve the problems. The purpose of the analysis is to ensure the regulatory agency systematically and comprehensively considers all available alternatives, so the public welfare can be enhanced in the most efficient and cost-effective way. The RIR addresses many of the items in the regulatory philosophy and principles of Executive Order 12866.

The RIR analysis and an environmental analyses required by NEPA have many common elements and they have been combined in this document. The following table shows where the elements of an RIR, as required by EO 12866, are located.

Required RIR Elements Corresponding Sections	
Description of management objectives	1.2, 1.4, 1.5
Description of the fishery	3.3
Statement of the problem	1.2
Description of each alternative considered in the analysis	2.1
An analysis of the expected economic effects of each alternative	4.4, 4.5 (Appendices H and I)

The RIR is designed to determine whether the proposed actions could be considered a significant regulatory action according to EO 12866. The Executive Order 12866 tests requirements used to assess whether or not an action would be a "significant regulatory action" and the expected outcomes of the proposed management alternative are discussed below. A regulatory program is economically significant if it is likely to result in the following effects:

1. Have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or state, local, or tribal governments or communities.

Income impacts in all Council managed salmon fisheries combined have been less than $100 million since at least 1991. Combined commercial and recreational coastal community impacts are not expected to be greater than $63 million under any of the alternatives considered in this analysis.

None of the alternatives considered in this EA are expected to adversely affect the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or state, local, or tribal governments or communities. All of the alternatives considered are expected to provide beneficial effects for the economy, jobs, and communities, while not incurring any significant adverse affects on KFRC or any other aspect of the environment. For example, long-term income impact estimates for the commercial ocean salmon fishery range from $13.2 million under the Status Quo Alternative to $18.4 million under the 13% Cap Alternative (Table 4-19).

2. Create a serious inconsistency or otherwise interfere with action taken or planned by another agency.

The alternatives considered would not alter the way related agencies interact with the Council or react to regulations promulgated by the Secretary. The alternatives would facilitate more efficient regulatory processes by providing more certainty to likely Council actions because the use of emergency rules to implement fisheries would be reduced. This would help ensure the California Fish and Game Commission would have sufficient time to structure Klamath River recreational fisheries and implement concurrent nearshore ocean fishery regulations. It would also allow tribal governments to structure their fisheries in a more timely manner.

3. Materially alter the budgetary impact of entitlement, grants, user fees, or loan programs or the rights and obligations of recipients thereof.

The Preferred Alternative would not result in ocean salmon fisheries substantially different from those experienced in recent years, and there are no new entitlements, grants, user fees, or loan programs associated with the Preferred Alternative. Therefore, no budgetary impacts are anticipated under the preferred Alternative.

4. Raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in this Executive Order.

The alternatives considered are not novel management policies for Council area salmon fisheries, and are not expected to raise any legal or policy issues. Other FMU stocks are managed in a manner similar to that considered in the alternatives for KRFC. Fisheries in 1992 and 2006 were prosecuted through emergency rules when KRFC stock status conditions were comparable to those contemplated under the alternatives. As detailed in other parts of this EA, the alternatives are consistent with MSA, ESA, and other applicable laws.

The key elements of an RIR have been thoroughly addressed in the EA above. It appears the proposed action in this amendment would not have any significant adverse economic effects on consumers and producers of salmon. Conversely, economic effects are expected to be either neutral or positive relative to the Status Quo.

5.5.2 Impacts on Small Entities (Regulatory Flexibility Act, RFA)

The RFA requires government agencies to assess the effects that various regulatory alternatives would have on small entities, including small businesses, and to determine ways to minimize those effects. A fish-harvesting business is considered a "small" business by the Small Business Administration (SBA) if it has annual receipts not in excess of $3.5 million. For related fish-processing businesses, a small business is one that employs 500 or fewer persons. For marinas and charter/party boats, a small business is one with annual receipts not in excess of $5.0 million. Commercial salmon harvesting vessels buyers/processors, and charter/party boats are expected to be the only type of small entities directly impacted by the proposed action.

Section 603 (b) of the RFA identifies the elements that should be included in the IRFA. These are bulleted below, followed by information that addresses each element.

- A description of the reasons why action by the agency is being considered.

The purpose and need for the proposed action are discussed in Sections 1. 2.

- A succinct statement of the objectives of, and legal basis for, the proposed rule.

The description of need in Section 1.2 also outlines the objectives of the proposed action the legal basis for the proposed action (proposed rule).

- A description and, where feasible, an estimate of the number of small entities to which the proposed rule will apply.

Section 3.3 and Section 4.4 describe the fishing sectors, processors, and communities, and the expected affects of the alternatives on those entities. Additional material specific to the IRFA is included below.

- A description of the projected reporting, record-keeping, and other compliance requirements of the proposed rule, including an estimate of the classes of small entities that will be subject to the requirements of the report or record.

There were no new reporting or record-keeping requirements that are proposed as part of this action.

- An identification, to the extent practicable, of all relevant federal rules, which may duplicate, overlap, or conflict with the proposed rule.

No federal rules have been identified that duplicate, overlap, or conflict with the alternatives. Public comment is hereby solicited, identifying such rules.

- A description of any significant alternatives to the proposed rule that accomplish the stated objectives that would minimize any significant economic impact of the proposed rule on small entities.

This EA includes a range of alternatives and their socioeconomic impacts, which were considered by the Council.

The small entities that would be affected by the proposed action are the vessels that compose the California and Oregon commercial salmon troll fleet and buyers/processors, the charter/party boat fleet between Cape Falcon, Oregon, and Point Sur, California, and other fishery dependent businesses. In years with sufficient surplus, the Yurok and Hoopa Valley tribes sell salmon in excess of their subsistence needs. The generally acknowledged minimum subsistence need is about 12,000 KRFC. In years that a Conservation Alert is triggered, it is unlikely the tribal share would exceed 12,000 KRFC; therefore there would be no difference in economic impact to tribal businesses between the Status Quo and Preferred alternatives. Therefore, no analysis of the tribal fishery in included in this IRFA.

Salmon Troll Fleet

The financial impacts analysis focuses on the ex-vessel revenue affects of each alternative on salmon troll vessels. Because cost data are lacking for the harvesting operations of salmon troll vessels, it was not possible to evaluate the financial impacts from estimated changes in salmon landings, under each allocation alternative, in terms of vessel profitability. Instead, financial impacts were evaluated based only on changes in salmon ex-vessel revenues relative to the Status Quo Alternative.

Vessel counts are based on unique vessel identifiers. However, it is known that in many cases a single firm may own more than one vessel; therefore, the counts should be considered upper bound estimates. Additionally, businesses owning vessels may have revenue from fisheries in other geographic areas, such as Alaska, or from non-salmon fishing activities. Therefore, it is likely that when all operations of a firm are aggregated, some of the small entities identified here are actually larger than indicated.

Approximately 2,718 vessels were permitted to operate in the commercial salmon troll fisheries in Oregon and/or California in 2005, although the active fleet was considerably smaller, with an average of approximately 1,068 vessels participating in 2003-2005(Table 4-20). In addition, only about 13%-19% of the active fleet landed 50% of the catch, and 52%-55% of the fleet landed 90% of the catch in those years (STT 2006a). Of the 1,068 vessels, 40% participated only in salmon fisheries, while the other 60% participated in multiple fisheries (Appendix K, Table K-4).All of these vessels would be considered small businesses under the SBA standards. The active fleet participation is dynamic with respect to annual opportunity in the salmon fishery. In years with less opportunity, some salmon vessels choose not to participate, and either engage in other fisheries or sell out. In years with more opportunity, previously inactive vessels may choose to participate, or may be sold to more active fishermen.

Under the Status Quo Alternative, there would be no participation in the commercial salmon fishery between Cape Falcon, Oregon and Point Sur, California during years that a Conservation Alert was triggered. Under the fixed cap alternatives, the active fleet was projected to be approximately 268 to 354 (Table 4-20).

The 2003-2005 average salmon related revenue per troll vessel was estimated at $20,900 (Appendix K, Table K-5). For salmon only troll vessels the average was $14,300 and for multiple species troll vessels the average was $25,200. Under the fixed cap alternatives, the average salmon-related revenue was projected at $1.6 million to 3.1 million in a Conservation Alert Year and applying a medium troller success rate scenario (Appendix K, Table K-3).

Processors/Buyers

A relatively small number of large processor/buyer firms handle most of the ocean salmon catch on the West Coast. There were 464 firms with state processor/buyer licenses that sold salmon in Oregon and California in 2004 (PFMC and NMFS 2006). These firms include both operators of processing plants and buyers that may do little more than hold the fish prior to their shipment to a processor or market. In some cases, the buyers may be owners of vessels who also own licenses allowing them to sell fish directly to the public or retail markets. Most larger salmon buying firms acquire fish from sites in more than one port. The largest salmon buyers tend to buy salmon from many vessels landing and buy fish in several ports. The top ocean caught salmon buying firms include some firms that are not among the top fish buyers when all species are counted. Larger processing firms are more likely to handle ocean caught salmon than smaller firms. However, there are many small buyers that specialize in salmon, only handle small amounts of product, and receive product from one or two vessels. It is likely that most of these buyers are vessels that also have licenses allowing them to sell directly to the public or other retail outlets (e.g., restaurants).

A thorough analysis of the effects of the Preferred Alternative would include estimates of the numbers of vessels acting as buyers/processors, as well as other buyer/processor sectors, the recent history of revenue generated by the various classes of buyer/processors, and a projection of revenue generated under the Status Quo and Preferred alternatives in Conservation Alert years. However, because many of the small business buyer/processors include vessel ownership, and because most buyer/processors deal in multiple fisheries, it is likely the effects of the Preferred Alternative are proportional to those estimated and projected for the salmon troll fleet above.

Charter/Party Boats (Incomplete)

Approximately 103 charter boats participated in California recreational ocean salmon fisheries in 2003-2005 (STT 2006a). In Oregon, there was an average of 211 licensed charter vessels during these same years. An estimated 6% of the Oregon charter effort occurred in the Astoria area during 2003-2005 (STT 2006a). The Astoria vessels

Approximately 103 charter boats participated in California recreational ocean salmon fisheries in 2003-2005 (STT 2006a). In Oregon there was an average of 211 licensed charter vessels. There was no information available for port of operation for Oregon charter vessels, but an average of 18% of Oregon charter based salmon trips originated in the Astoria area. There was also no information available on fishery participation for Oregon vessels, and some may not have engaged in salmon fishing. Conversely, it is likely that most of the Charter fleet in both states participated in fisheries other than salmon, such as California halibut, Pacific Halibut, bottomfish, and albacore.

Separate economic impact estimates were not available for charter and private boat salmon fishing sectors; however during 2003-2005, Oregon and California recreation salmon fishing effort averaged 297,200 days for both boat types, with charter boat fishing averaging 31% of the total during. Based on this assumption the projected state level income impact of the *de minimis* fishery alternatives under the fixed cap alternatives in a CAY ranged from $6.2 million to $6.8 million dollars. For the Status Quo Alternative the economic impact was about $322,000. Based on an assumed fleet of 314 vessels, the average economic impact per vessel was about $3,200 for the Status Quo Alternative and $19,700 to $21,700 annually for the fixed cap alternatives.

Other Small Businesses

In addition to commercial fishing vessels, other fishery-dependent businesses that may be affected include suppliers, buyers who act as intermediaries between vessels and consumers, processors who purchase raw materials from commercial vessels to produce seafood products, and charter or party vessels that provide recreational fishing experience for paying customers, among others. A thorough accounting of net benefits would include measurement of producer surpluses accruing to these business sectors as well as to fishing vessels.

6.0 PROPOSED MODIFICATIONS TO SALMON FMP VERBIAGE RELATED TO *DE MINIMIS* FISHING LEVELS FOR KRFC

3.2.2 Conservation Alert

3.2.2.1 Criteria

A conservation alert is triggered during the annual preseason process (Chapter 9) if a natural stock or stock complex, listed in Table 3-1 of the Salmon FMP, is projected to fall short of its conservation objective (spawner goal, exploitation rate, etc. representing MSY, MSY proxy, or MSP). While a projected one-year shortfall may be of little biological concern, it may also represent the beginning of production problems and is worthy of note to help prevent future stock decline.

3.2.2.2 Council Action

For all natural stocks which meet the conservation alert criteria, the Council will notify pertinent fishery and habitat managers, advising that the stock may be temporarily depressed or approaching an Overfishing Concern (depending on its recent conservation status), and request that state and tribal fishery managers identify the probable causes, if known. If the stock in question has not met its conservation objective in the previous two years, the Council will request the pertinent state and tribal managers to do a formal assessment of the primary factors leading to the shortfalls and report their conclusions and recommendations to the Council no later than the March meeting prior to the next salmon season.

The Council will take the following actions for stocks which trigger a conservation alert that do not qualify as exceptions under Section 3.2.4 (see Table 3-1):

1. Close salmon fisheries within Council jurisdiction that impact the stock.

2. In the case of Washington coastal and Puget Sound salmon stocks and fisheries managed under U.S. District Court orders, the Council may allow fisheries which meet annual spawner targets developed through relevant *U.S. v. Washington*, *Hoh v. Baldrige*, and subsequent U.S. District Court ordered processes and plans, which may vary from the MSY or MSP conservation objectives. ~~Other than the exceptions noted above, the Council may not recommend ocean salmon fisheries which are expected to trigger a conservation alert.~~

3. In the case of Klamath River fall Chinook, the Council may allow *de minimis* fisheries, which: permit an ocean impact rate of no more than [Insert Preferred Alternative here] on age-4 Klamath River fall Chinook if the projected natural spawning escapement associated with a [Preferred Alternative] age-4 ocean impact rate, including river recreational and tribal impacts, is less than 35,000. Ocean fishery impacts to the returning brood incurred during the previous fall will be counted against the allowable [Preferred Alternative] age-4 ocean impact rate. Implementation of *de minimis* fisheries will depend on year specific estimates of ocean abundance and age composition, and will be determined by the STT prior to the March Council meeting.

Other than the exceptions noted above, the Council may not recommend ocean salmon fisheries which are expected to trigger a conservation alert.

If postseason estimates confirm that a stock conservation objective is not met, a rebuilding program for the following year is implicit in the conservation objective since it is based on annually meeting MSY or

MSP. In addition, the Council reviews stock status annually and, where needed, identifies actions required to improve estimation procedures and correct biases. Such improvements provide greater assurance that objectives will be achieved in future seasons. Consequently, a remedial response is built into the preseason planning process to address excessive fishing mortality levels relative to the conservation objective of a stock.

The Council does not consider that a one year departure from the MSY/MSP spawner objective for salmon affects the capacity of a stock to produce MSY over the long-term (i.e., does not constitute overfishing as defined by the Magnuson-Stevens Act). However, the Council's use of a conservation alert and the rebuilding effect of the conservation objectives provides for sound resource management and responds to the concept in the National Standard Guidelines for action to address overfishing concerns in any one year. The Council's conservation objectives which are used to trigger a conservation alert are generally based on MSY or MSP rather than a minimum stock size threshold. In this respect, the Council's management approach is more conservative than recommended by the National Standard Guidelines.

7.0 LITERATURE CITED

CDFG (California Department of Fish and Game). 1982. Derivation of Klamath River fall Chinook escapement goal. Ocean Salmon Project, CDFG, Santa Rosa CA 95403. 3p.

Goldwasser, L., M. S. Mohr, A. M. Grover, and M. L. Palmer-Zwahlen. 2001. The supporting databases and biological analyses for the revision of the Klamath Ocean Harvest Model. Unpublished report. National Marine Fisheries Service, Southwest Fisheries Science Center, Fisheries Ecology Division, Santa Cruz, CA.

Hubbell, P.M., and LB Boydstun. 1985. An assessment of the current carrying capacity of the Klamath River Basin for adult fall chinook salmon. Calif. Dept. Fish and Game, Inland Fish. Div., Sacramento, CA 95814. 17 p.

KRTAT (Klamath River Technical Advisory Team). 1999. Population dynamics of Klamath River fall Chinook salmon: stock-recruitment model and simulation of yield under management. Technical Report to Klamath Fishery Management Council. U.S. Fish and Wildlife Service, Yreka Fish and Wildlife Office, Yreka, CA., 96097 42p.

KRTT (Klamath River Technical Team). 1986. Recommended spawning escapement policy for Klamath River fall-run Chinook. Technical report to Klamath River Salmon Management Group. U. S. Fish and Wildlife Service. Yreka CA 96097. 73p.

OSP (Ocean Salmon Project). 1985. Summary of Meeting, Klamath River Salmon Management Group, May 23, 1985, San Francisco Airport Holiday Inn. File document. OSP, Calif. Dept. Fish and Game, Santa Rosa CA 95403. 6p.

_____. 1986. Harvest sharing agreement. OSP, Calif. Dept. Fish and Game, Santa Rosa CA 95403.

Mohr, M. et al (find it)

NMFS (National Marine Fisheries Service). 1996. Endangered Species Act - Section 7 Consultation - Biological Opinion: The Fishery Management Plan for Commercial and Recreational Salmon Fisheries off the Coasts of California, Oregon, and Washington of the Pacific Fishery Management Council. NMFS, Protected Resources Division. March 8, 1996. 53 pp.

NMFS. 1999. Endangered Species Act - Section 7 Consultation. Supplemental Biological Opinion and Incidental Take Statement on the Pacific Coast Salmon Plan and Amendment 13 to the Plan. April 28, 1999. 39 pp. (with appendices).

PFMC (Pacific Fishery Management Council).1983. Proposed plan for managing the 1983 salmon fisheries off the coasts of California, Oregon, and Washington: an amendment to the FMP for commercial and recreational salmon fisheries off the coast of Washington, Oregon, and California commencing in 1978. PFMC, Portland OR. 5 sections plus appendices.

_____. 1986. Report of the Klamath River Salmon Management Group. Supplemental Exhibit B.6., March 6, 1986. PFMC, Portland OR. 5p.

_____. 1988. Ninth amendment to the fishery management plan for commercial and recreational salmon fisheries off the coasts of Washington, Oregon and California commencing in 1978. PFMC, Portland OR 97201.

_____. 1992. Pre-season report 3. Pac. Fish. Mgmt. Council, Portland OR

_____. 1994. Klamath River fall Chinook review team report. PFMC, Portland OR 97201. 24p. (see: http://www.pcouncil.org/salmon/salother/krfcrtr1294.pdf).

_____. 1997. Pacific Coast Salmon Plan. PFMC Portland OR (see: http://www.pcouncil.org/salmon/salfmp/fmpthrua14.pdf).

_____. 1999. Final amendment 13 to the Pacific Coast salmon plan. PFMC, Portland OR. 84 p. (see: http://www.pcouncil.org/salmon/salfmp/finala13.pdf).

_____. 2005. November Meeting Minutes, Agenda Item G.3.d: Report of Fishery Management Council. (see: http://www.pcouncil.org/minutes/2005/1105min.pdf).

_____. 2006. Klamath Fishery Management Council report on the Klamath River fall Chinook conservation objective. Agenda Item C.7.a. Attachment 1. March 2006. PFMC, Portland OR. 2p.

PFMC and NMFS. 2006. Proposed acceptable biological catch and optimum yield specifications and management measures for the 2007-2008 Pacific coast groundfish fishery, and amendment 16-4: rebuilding plans for seven depleted Pacific coast groundfish species; final environmental impact statement including regulatory impact review and initial regulatory flexibility analysis. Pacific Fishery Management Council, Portland, OR. October 2006.

Pierce, R.M. 1998. Klamath salmon: understanding allocation. Pamphlet published by Klamath River Basin Fisheries Task Force and U.S. Fish and Wildlife Service. Available from Yreka Fish and Wildlife Office, U.S. Fish and Wildlife Service, 1829 S. Oregon Street, Yreka, California 96097.

Prager, M. H., and M. S. Mohr. 2001. The harvest rate model for Klamath River fall chinook salmon, with management applications and comments on model development and documentation. North American Journal of Fisheries Management 21(3):533-547.

SSC (Scientific and Statistical Committee). 2005. Scientific and Statistical Committee Klamath River fall Chinook conservation objective. PFMC, Agenda Item G.3.b, supplemental SSC report, November 2005. PFMC. Portland OR 97220. 1p.

_____. 2006. Scientific and Statistical Committee report on the supplemental National Marine Fisheries Service report. PFMC, Agenda Item E.2.g, supplemental SSC report, April 2006. PFMC. Portland OR 97220. 2p.

STT (Salmon Technical Team). 2005a Salmon Technical Team Report on the Technical Basis for the Klamath River fall Chinook conservation objective. PFMC agenda item D.1b, STT Report, June 2005. 7p. (see: http://www.pcouncil.org/bb/2005/0605/ag_d1.pdf).

_____. 2005b. Klamath River Fall Chinook Stock-recruitment analysis. Agenda Item G.1.b, Sept 2005. PFMC, Portland OR 97220. 36p. (see: http://www.pcouncil.org/salmon/salother/G1b_KlamathConsObj_STT_Rpt.pdf)

_____. 2006a. Review of 2005 Ocean Salmon Fisheries. PFMC, Portland OR 97220. 311 p.

_____. 2006b. Salmon Technical Team report on Fort Bragg March 15, 2006 commercial fishery opening. Agenda Item C.2.c, March 2006. PFMC, Portland OR 97220. 2p.

_____. 2006c. Pre-season Report II, Appendix A: KOHM adjustments for 2006 fisheries. PFMC, Portland OR 97220. 54 p.

Thomson, C.J. In review. Results of the 2004 Economic Survey of Inriver Salmon and SteelheadAnglers in California. NOAA Technical Memorandum.

Yurok Tribe 2006. Yurok Tribe Discussion Paper Regarding Fishery Disaster Assistance. Yurok Tribe, Eureka CA. 10p.

APPENDIX A: COMMITTEE MEMBER NAMES AND AFFILIATIONS

Document Subcommittee

L.B. Boydstun, CDFG, retired	Primary role for document drafting and construction
Ray Beamesderfer, Cramer Fish.	Primary role for population dynamics modeling
Larrie LaVoy, WDFW	Primary role for population dynamics modeling
Corinne Pinkerton, NMFS SWR	Primary role for fishery economic analysis
Chuck Tracy, Council staff	Document subcommittee staffing
Mike Burner, Council staff	Document subcommittee staffing

Regulatory Streamlining Subcommittee

Eric Chavez, NMFS HQ, and SWR
Peter Dygert, NMFS HQ, and NWR
Chris Wright, NMFS HQ
Kit Dahl, Council staff
Mariam McCall, NOAA GC, NWR

Remainder of Full Committee (in addition to above members)

Allen Grover, CDFG	Fishery management and policy analysis
Craig Foster, ODFW	Fishery management and policy analysis
Michael Mohr, NMFS-SWFSC	Population dynamics analysis
Robert Kope, NMFS-NWFSC	Population ecology analysis
Gary Morishima, STT	Population dynamics and fishery management
Pete Lawson, NMFS-NWFSC	Population dynamics analysis
George Kautsky, Hoopa Tribe	Fishery management and policy analysis
Dave Hillemeier, Yurok Tribe	Fishery management and policy analysis
Cindy Thomson, NMFS-SWFSC	Fishery economic analysis
Duncan MacLean, SAS, Troll	Fishery management and policy analysis
Dan Wolford, SAS, Sport	Fishery management and policy analysis
Jim Seger, Council staff	Economic analysis

APPENDIX B: DESCRIPTION OF KLAMATH BASIN ADULT SALMONID ESCAPEMENT MONITORING PROGRAMS

Area	Race	Method	Metrics	*Agency*
Iron Gate Hatchery	Fall Chinook	Actual count	Annual escapement, bio-samples	*DFG*
Trinity River Hatchery	Fall Chinook and Spring Chinook	Actual count	Annual escapement, bio-samples	*DFG*
Bogus Creek	Fall Chinook	Video count over weir, direct carcass count below weir	Annual escapement, bio-samples	*DFG*
Main Stem Klamath (IGH to Shasta River)	Fall Chinook	Carcass mark-recapture	Annual escapement/ Spawning distribution/bio-samples	*USFWS*
Main Stem Klamath (Shasta River to Indian Creek)	Fall Chinook	Flagging of weekly redd counts times 2	Annual escapement	*USFWS*
Shasta River	Fall Chinook, coho salmon and steelhead	Video count through weir	Annual escapement, bio-samples collected from carcasses	*DFG*
Scott River	Fall Chinook	Carcass mark-recapture	Annual escapement/ spawner distribution, bio samples	*DFG and volunteers*
Salmon River	Fall Chinook	Carcass mark-recapture	Annual escapement/ spawner distribution, bio samples	*DFG, USFS and volunteers*
	Spring Chinook	Snorkel Survey	Annual run size/ spawner distribution	*USFS, DFG*
Klamath River tributaries	Fall Chinook	Redd flagging times 2 plus live fish counts	Annual escapement/ spawner distribution	*DFG*
Yurok Reservation Tributaries	Fall Chinook	Weekly snorkel counts—Blue Creek only	Annual escapement/ spawner distribution	*Yurok Tribe*
Hoopa Reservation Tributaries	Fall Chinook	Redd counts times 2	Annual escapement/ spawner distribution	*Hoopa Valley Tribe*
Trinity River (includes SF Trinity)	Fall Chinook, coho, steelhead	Live fish mark-recapture using portable weir at Willow Creek: Petersen expansion; redd counts times 2 below weir	Annual run size and fishery harvest (tag returns), bio-samples	*DFG*
Trinity River above Junction City	Spring Chinook	Live fish mark-recapture using portable weir: Petersen expansion	Annual run size and fishery harvest (tag returns)	*DFG*

Bio-samples include scales, fork lengths, marks.
CDFG = California Department of Fish and Game; USFWS = US Fish and Wildlife Service; USFS = US Forest Service

APPENDIX C: OCEAN FISHERY CONTRIBUTION ESTIMATES FOR HATCHERY AND NATURAL ORIGIN FISH

(Source: Ocean Salmon Project, CDFG)

Table C-1. Ocean fishery contribution estimates for hatchery and natural origin fish, 1983-2004 catch years (source: Ocean Salmon Project, CDFG).

	Hatchery					Natural					Totals				
Year	2	3	4	5	Totals	2	3	4	5	Totals	2	3	4	5	Totals
1983	56	9,207	18,561		27,824	99	59,209	54,331		113,639	155	68,416	72,892	0	141,463
1984	36	3,392	7,383	147	10,958	0	10,401	26,377	1,555	38,333	36	13,793	33,760	1,702	49,291
1985	1,090	14,019	4,884	359	20,352	4,364	32,524	9,901	3,149	49,938	5,454	46,543	14,785	3,508	70,290
1986	109	79,425	12,139	59	91,732	190	189,806	56,589	2,495	249,080	299	269,231	68,728	2,554	340,812
1987	279	32,645	53,036	56	86,016	488	106,640	102,410	9,474	219,012	767	139,285	155,446	9,530	305,028
1988	0	63,730	29,537	1,480	94,747	0	105,026	69,351	7,708	182,085	0	168,756	98,888	9,188	276,832
1989	0	19,037	29,296	956	49,289	0	44,159	38,155	2,596	84,910	0	63,196	67,451	3,552	134,199
1990	99	7,460	9,949	890	18,398	500	50,755	50,106	4,626	105,987	599	58,215	60,055	5,516	124,385
1991	0	1,193	1,466	51	2,710	0	1,189	5,608	1,273	8,070	0	2,382	7,074	1,324	10,780
1992	69	151	836	64	1,120	90	917	1,364	67	2,438	159	1,068	2,200	131	3,558
1993	20	4,568	220	29	4,837	114	4,219	2,439	896	7,668	134	8,787	2,659	925	12,505
1994	0	968	2,266	141	3,375	0	3,308	1,597	70	4,975	0	4,276	3,863	211	8,350
1995	0	9,913	900	108	10,921	0	20,250	2,983	324	23,557	0	30,163	3,883	432	34,478
1996	0	683	10,157	246	11,086	0	9,428	27,583	178	37,189	0	10,111	37,740	424	48,275
1997	0	620	344	672	1,636	0	1,686	3,457	2,382	7,525	0	2,306	3,801	3,054	9,161
1998	0	454	1,129	21	1,604	0	383	3,188	193	3,764	0	837	4,317	214	5,368
1999	0	879	1,595	63	2,537	0	1,284	1,295	320	2,899	0	2,163	2,890	383	5,436
2000	0	19,480	1,988	88	21,556	0	22,031	2,766	44	24,841	0	41,511	4,754	132	46,397
2001	0	2,857	3,930	32	6,819	0	7,414	9,646	13	17,073	0	10,271	13,576	45	23,892
2002	0	4,801	3,006	104	7,911	0	11,878	13,356	2,036	27,270	0	16,679	16,362	2,140	35,181
2003	0	2,465	16,661	325	19,451	0	6,620	38,146	564	45,330	0	9,085	54,807	889	64,781
2004	0	12,128	16,515	1,932	30,575	0	9,114	57,494	19,897	86,505	0	21,242	74,009	21,829	117,080
2005	0	3,650	5,424	1,005	10,079	0	6,062	6,350	2,122	14,534	0	9,712	21,242	3,127	24,613
Averages:	76	12,771	10,053	401	23,284	254	30,622	25,413	2,817	58,984	331	43,393	35,877	3,079	82,268
Proportion of combined:					28.3%					71.7%					100.0%

APPENDIX D: Mid-Klamath sub-stock effective population size analysis.

Probability of Escapement Falling Below a Critical Threshold in the Shasta, Scott, and Salmon Rivers and Effective Population Size Analysis

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Southwest Fisheries Science Center
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29 September 2006

Objective

We investigate the relationship between the number of Klamath River fall Chinook (KRFC) natural area adult spawners (*E*) and the number of KRFC adult spawners in the Shasta (E_1), Scott (E_2), and Salmon (E_3) Rivers. Our goal is to estimate the probability that the number of spawning adults in at least one of these three tributaries falls below a critical threshold (*c*), given that *E* is less than or equal to some specified number (*n*). This probability is a function of the tributary-specific probabilities of failing to meet the threshold given that $E = k; k \le n$, weighted by the probability that $E = k \mid E \le n$. We also examine the application of effective population size theory to protection of Klamath Basin sub-stocks.

Methods

Let $Q(c,k)$ denote the probability that escapement in at least one of these tributaries falls below the threshold *c* given that $E = k$. By definition:

$$\begin{aligned} Q(c,k) &= 1 - \Pr(E_1 \ge c, E_2 \ge c, E_3 \ge c \mid E = k) \\ &= 1 - \prod_{i=1}^{3} \Pr(E_i \ge c \mid E = k) \\ &= 1 - \prod_{i=1}^{3} \left[1 - \Pr(E_i < c \mid E = k)\right]. \end{aligned} \tag{1}$$

Let $P(c,n)$ denote the probability that escapement in at least one of these tributaries falls below the threshold *c* given that $E \le n$. By definition:

$$P(c,n) = \sum_{k=0}^{n} Q(c,k) \Pr(E = k \mid E \le n). \tag{2}$$

Thus, $P(c,n)$ can be estimated using equations 1 and 2 given estimates of $\Pr(E_i < c \mid E = k)$, *i*=1,2,3, and $\Pr(E = k \mid E \le n)$.

To develop estimates of $\Pr(E_i < c \mid E = k)$, *i*=1,2,3, we assume that E_i is proportional to *E* subject to multiplicative lognormal error:

$$E_i = \beta_i E \exp(\varepsilon_i), \quad \varepsilon_i \sim N(0, \sigma_i^2). \tag{3}$$

The model implies that

$$\log(E_i) = \alpha_i + \log(E) + \varepsilon_i, \tag{4}$$

with $\alpha_i = \log(\beta_i)$, and that

$$Z_i \sim N(\alpha_i, \sigma_i^2), \tag{5}$$

where $Z_i = \log(E_i / E)$. That is, the model assumes that the proportion of the basinwide natural area escapement that occurs in tributary *i* is, on the log-scale, normally distributed with mean α_i and variance σ_i^2.

The escapement log-proportion data $\left\{Z_{ij} = \log(E_{ij} / E_j);\ j = 1978, 1979, \ldots, 2005\right\}$ can be used to provide unbiased, minimum variance, estimates of the tributary *i* model parameters:

$$\hat{\alpha}_i = \bar{Z}_i, \qquad \hat{\sigma}_i^2 = \sum_{j=1}^{m} \left(Z_{ij} - \bar{Z}_i\right)^2 \Big/ (m-1), \tag{6}$$

with $m = 28$ years of escapement data. Under the model, the probability that $E_i < c$ in any particular future year given $E = k$ can then be estimated as

$$\begin{aligned} \Pr(E_i < c \mid E = k) &= \Pr\left(\frac{Z_i - \bar{Z}_i}{s_i} < \frac{\log(c/k) - \bar{Z}_i}{s_i}\right) \\ &= \Pr\left(t(m-1) < \frac{\log(c/k) - \bar{Z}_i}{s_i}\right), \end{aligned} \tag{7}$$

where $s_i^2 = \hat{V}(Z_i - \bar{Z}_i) = \hat{\sigma}_i^2\left(1 + (1/m)\right)$, and $t(m-1)$ is Student's *t* random variable with $m-1$ degrees of freedom. Note that the above probability is a function of *c* and *k*, and is tributary-specific, and when substituted into equation 1 provides an estimate of $Q(c,k)$.

The probability $P(c,n)$ additionally depends on $P(E = k \mid E \le n)$ (see equation 2) which is a function of the underlying population dynamics. For simulation model studies, $P(c,n)$ can be estimated as follows. Let $\left\{E_\tau;\ \tau = 1, 2, \ldots, T\right\}$ denote a simulated sequence of *E* values over a *T*-year period. Estimate $P(E = k \mid E \le n)$ by the corresponding relative frequency of the event: $\sum_{\tau=1}^{T} \mathrm{I}\left(E_\tau = k\right) \Big/ \sum_{\tau=1}^{T} \mathrm{I}\left(E_\tau \le n\right)$, where $\mathrm{I}(\cdot)$ is a 0-1 indicator function having value 1 if the statement is true and value 0 otherwise. Then, by equation 2,

$$\hat{P}(c,n) = \sum_{k=0}^{n} \hat{Q}(c,k) \frac{\sum_{\tau=1}^{T} \mathrm{I}\left(E_\tau = k\right)}{\sum_{\tau=1}^{T} \mathrm{I}\left(E_\tau \le n\right)} = \frac{\sum_{\tau=1}^{T} \hat{Q}(c,E_\tau)\,\mathrm{I}\left(E_\tau \le n\right)}{\sum_{\tau=1}^{T} \mathrm{I}\left(E_\tau \le n\right)} = \frac{\sum_{w=1}^{T_n} \hat{Q}(c,E_w)}{T_n}, \tag{8}$$

where $\left\{E_w; w = 1,2,\ldots,T_n\right\}$ is the subset of the simulated $\left\{E_\tau\right\}$ for which $E_\tau \le n$. That is, $\hat{P}(c,n)$ can be computed simply as the average value of $\hat{Q}(c,E_\tau)$ over the simulated years in which $E_\tau \le n$.

Results

All available historical escapement data are listed in Table D-1, and the $\left\{\overline{Z}_i\right\}$ and $\left\{s_i\right\}$ statistics are provided in Table D-2.

Scatter plots of the $\log(E_i)$ versus $\log(E)$ data are presented in Figure D-1, column 1. The model assumes that these data are linearly related with a constant residual variance (see equation 4). A line with intercept $\hat{\alpha}_i = \overline{Z}_i$ and slope 1 is superimposed on the plots. Histograms of the observed Z_i are shown in Figure D-1, column 2. The model assumes that these log-proportions are (approximately) normally distributed. In Figure D-1, column 3, the observed Z_i are presented as a time-series, along with $\overline{Z}_i$ (solid line) and a fitted local polynomial regression function (dashed line).

An illustration of the calculation of $\hat{Q}(c,n)$ follows for $c = 500$ and $n = 21000$. Substituting the Table D-2 values into equation 7 gives

$$\Pr\left(E_1 < 500 \mid E = 21000\right) = \Pr\left(t\left(27\right) < \frac{\log(500/21000) + 2.620}{0.740}\right) = 0.071,$$

$$\Pr\left(E_2 < 500 \mid E = 21000\right) = \Pr\left(t\left(27\right) < \frac{\log(500/21000) + 2.445}{0.612}\right) = 0.022,$$

$$\Pr\left(E_3 < 500 \mid E = 21000\right) = \Pr\left(t\left(27\right) < \frac{\log(500/21000) + 3.091}{0.726}\right) = 0.190.$$

The probabilities on the right side of the above equations are obtained by the cumulative distribution function of Student's *t* distribution with 27 degrees of freedom, evaluated at the quantity given on the right side of the inequalities. Substituting these probabilities into equation 1 gives

$$\hat{Q}(c = 500,\ n = 21000) = 1 - \left[(1-0.071)(1-0.022)(1-0.190)\right] = 0.264.$$

Figure D-2 plots $\hat{Q}(c,n)$ as a function of *n* for several values of *c*.

Discussion

Model Considerations

While the proposed model does an adequate job of characterizing the relationship between KRFC tributary and basin natural area adult escapement, there are some features of the data that are not accurately captured by the model. The log-proportion time-series plots (Figure D-1, column 3) reveal some trends in the Z_i. For the Shasta River, there was a precipitous decline in the log-proportion from 1982–1986, and since that time Z_1 has varied about an average value of –2.957 (versus –2.620 for the entire time series). For both the Scott and Salmon Rivers, the log-proportion values for 2004 and 2005 standout as very low compared to the historical norm, and for the Salmon River the log-proportion has been in decline since 1990, with the Z_3 values for the last eight years being less than the long-term average.

Removing the 2004 and 2005 data points from the analysis has no effect on the Shasta River results, but the Scott and Salmon River $\overline{Z}_i$ increase in magnitude by about 0.10, and s_i decreases by about 0.13 and 0.07, respectively. This has the effect of reducing, for example, the $\Pr(E_2 < 500 \mid E = 21000)$ by 0.02, and the $\Pr(E_3 < 500 \mid E = 21000)$ by 0.05. Taken together, this reduces $\hat{Q}(c,k)$ by a maximum of 0.08 over the range of *c* and $E = k$ examined in this report. On the other hand, as pointed out above, if the recent lows are more indicative of the current and future state of the system than the long-term observed averages and variation, then the $\hat{Q}(c,k)$ presented in this report could be seriously biased low. Therefore, greater credence should be given to relative values of $\hat{Q}(c,k)$ and $\hat{P}(c,n)$ than their absolute magnitude.

Model Application: Effective Population Size Theory

Conservation biologists, who are concerned with the extinction of populations and species, often use an *effective population size per generation* of $N_e = 500$ as a general rule of thumb for the minimum size of a population. The "500 rule" can be traced to the work of Franklin (1980) and Soulé (1980), who showed that populations with $N_e < 500$ per generation lose diversity in quantitative traits faster than it can be replaced by mutation. Two steps must be taken to apply this theory to salmon. First, N_e is generally much smaller than the *number of adult spawners per generation*, *N*, and Waples (2004) has found that $N_e/N \approx 0.2$ for Pacific salmon. Thus $N_e = 500$ is approximately equivalent to $N = 500/0.2 = 2500$. Second, for ease of application, *N* must be converted into an equivalent *number of adult spawners per year*, $E = N/g$, based on the average generation length, *g* (Waples, 1990). For Klamath River fall Chinook, the average annual mature adult age-composition over the 1981–2005 period (KRTAT, 2006) is (p_3, p_4, p_5) = (0.55, 0.42, 0.03), so that $g = \sum_{a=3}^{5} a \cdot p_a$ = 3.48 years. Therefore, $N_e = 500$ is approximately equivalent to $E = 2500/3.48 \approx 720$ adult spawners per year. We note that this rational has been used to prioritize stocks for conservation (Allendorf, 1997) and to set minimum population sizes for recovery under the ESA (Lindley et al., In press).

References

Allendorf, F. W., D. Bayles, et al. (1997). Prioritizing Pacific salmon stocks for conservation. Conservation Biology 11: 140–152.

Franklin, I. R. (1980). Evolutionary changes in small populations. Conservation biology: an evolutionary-ecological perspective. M. E. Soulé and B. A. Wilcox. Sunderland, MA, Sinauer Associates: 135–149.

Lindley, S. T., R. S. Schick, et al. (In press.). Framework for assessing viability of threatened and endangered Chinook salmon and steelhead in the Sacramento-San Joaquin basin. San Francisco Estuary and Watershed Science.

Soulé, M. E. (1980). Thresholds for survival: maintaining fitness and evolutionary potential. Conservation biology: an evolutionary-ecological perspective. M. E. Soulé and B. A. Wilcox. Sunderland, MA, Sinauer Associates: 151–170.

Waples, R. S. (1990). Conservation genetics of Pacific salmon. II. Effective population size and the rate of loss of genetic variability. Journal of Heredity 81: 267–276.

Waples, R. S. (2004). Salmonid insights into effective population size. Evolution illuminated: salmon and their relatives. A. P. Hendry and S. C. Stearns. Oxford, Oxford University Press: 295–314.

Table D-1. KRFC adult natural area escapement.

Year	Adult Natural Escapement			
	Shasta (E_1)	Scott (E_2)	Salmon (E_3)	Basin (E)
1978	12024	3423	2600	58492
1979	7111	3396	1000	30637
1980	3762	2032	800	21483
1981	7890	3147	750	33857
1982	6533	5826	1000	31951
1983	3119	3398	1200	30784
1984	2362	1443	1226	16064
1985	2897	3051	2259	25677
1986	3274	3176	2716	113360
1987	4299	7769	3832	101717
1988	2586	4727	3273	79386
1989	1440	3000	2915	43868
1990	415	1379	4071	15596
1991	716	2019	1337	11649
1992	520	1873	778	12028
1993	1341	5035	3077	21858
1994	3363	2358	3216	32333
1995	12816	11198	4140	161794
1996	1404	11952	5189	81326
1997	1667	8284	5783	46144
1998	2466	3061	1337	42488
1999	1296	3021	670	18457
2000	11025	5729	1544	82728
2001	8452	5398	2607	77834
2002	6432	4261	2669	65635
2003	4134	11988	3302	87642
2004	833	445	282	23831
2005	2018	698	401	27305

Table D-2. KRFC adult natural area escapement log-proportion statistics.

Tributary	$\bar{Z}_i$	s_i
Salmon $(i=1)$	-2.620	0.740
Scott $(i=2)$	-2.445	0.612
Shasta $(i=3)$	-3.091	0.726

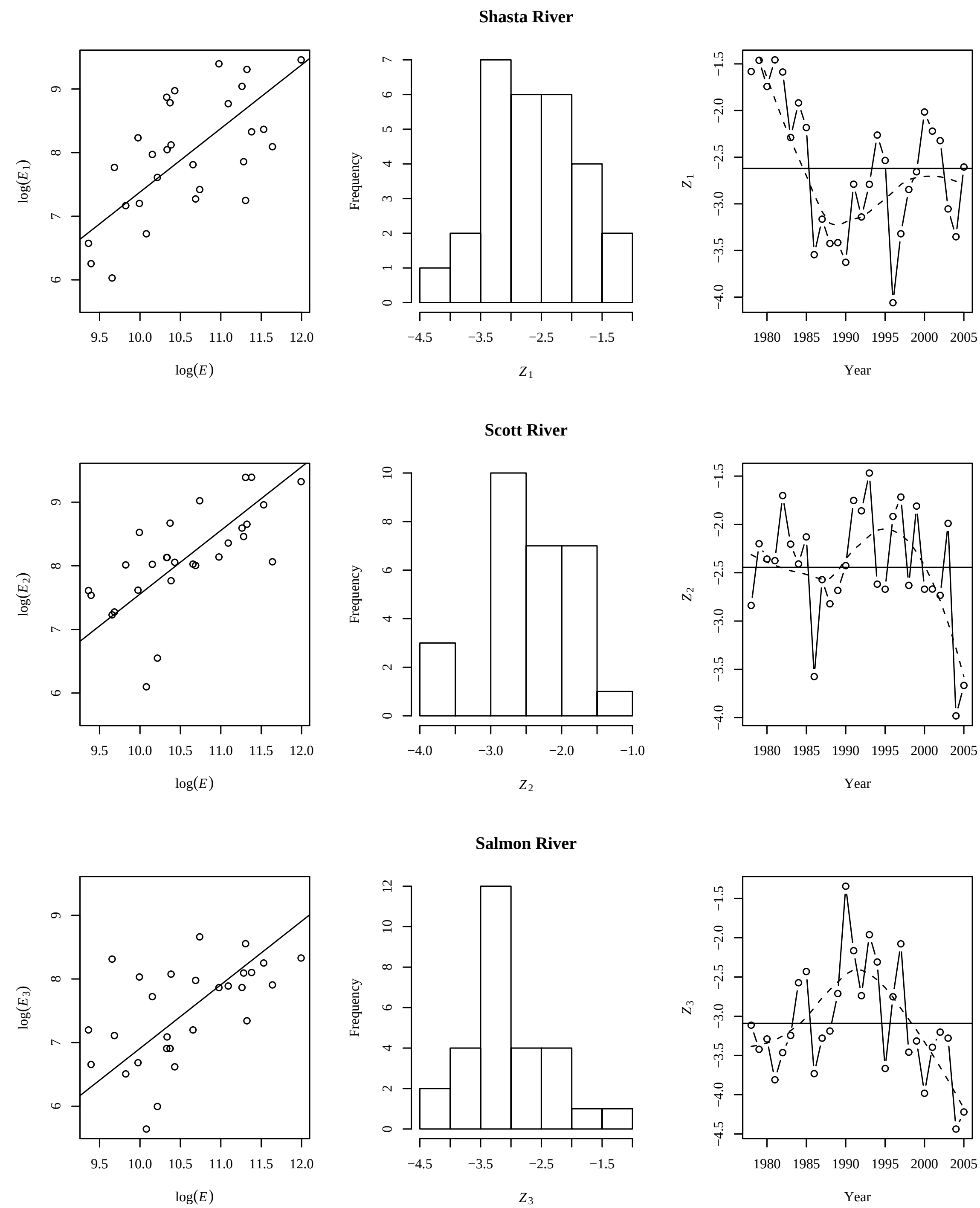

Figure D-1. KRFC adult natural area escapement log-proportion data and statistics.

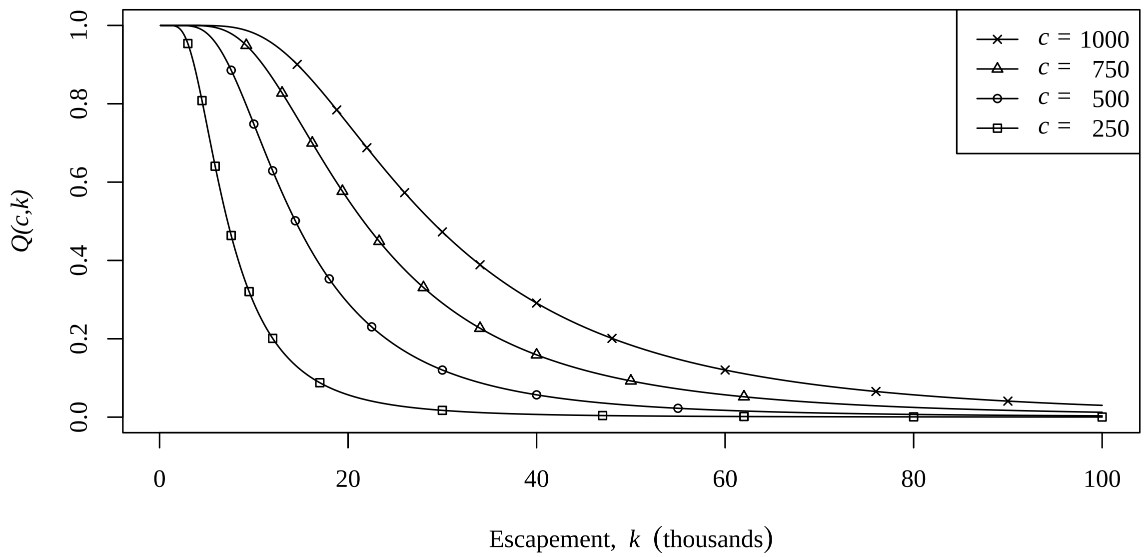

Figure D-2. Probability that KRFC adult escapement in either the Shasta, Scott, or Salmon Rivers falls below the critical level, *c*, as a function of total KRFC natural area adult escapement.

APPENDIX E: FORMULAS AND DATA USED IN THE HINDCAST ANALYSIS.

Escapement Goals Under the *De Minimis* Fishery Alternatives

The adult natural (n) area spawning escapement (E_n) goal under the status quo (E_n^{Q}), sliding scale (E_n^{S}), and fixed-cap (E_n^{F}) *de minimis* fishery alternatives are, respectively:

$$E_n^{\mathrm{Q}} = \begin{cases} E_n^0 & \text{, when } E_n^0 \le 35,000 \\ 35,000 & \text{, when } 35,000 < E_n^0 \le 105,000 \\ E_n^0 / 3 & \text{, when } E_n^0 > 105,000 \end{cases} \tag{0.9}$$

$$E_n^{\mathrm{S}} = \begin{cases} E_n^0 (1 - 0.09(E_n^0 / 35,000)) & \text{, when } E_n^0 \le 38,889 \\ E_n^{\mathrm{Q}} & \text{, when } E_n^0 > 38,889 \end{cases} \tag{0.10}$$

$$E_n^{\mathrm{F}} = \min(E_n^0 - I_{n\text{-SE}}^{\mathrm{F}} \; , E_n^{\mathrm{Q}}), \tag{0.11}$$

where E_n^0 is the natural area escapement absent fisheries, and $I_{n\text{-SE}}^{\mathrm{F}}$ is the total number of impacts (all fisheries) under the fixed-cap alternative of natural area destined fish in spawner equivalent (SE) units[7] (Table 1 provides a list of notation). The quantity $I_{n\text{-SE}}^{\mathrm{F}} / E_n^0$ is not a fixed fraction under the fixed-cap alternative—not even in a particular year—as it depends on season-structure, age-structure, user-group harvest allocation, etc.

The natural area escapement absent fisheries is

$$E_n^0 = \sum_{a=3}^{5} R_a^0 \times g_a, \tag{0.12}$$

with

$$R_a^0 = N_a \times S_a \times m_a \times (1 - w_a), \tag{0.13}$$

where the subscript a denotes age {3,4,5}, R_a^0 is the river run abundance absent fisheries, g_a is the proportion of spawners that are destined for natural areas, N_a is the starting (Sept 1) ocean abundance,

[7] SE units are the number of the referred to quantity that would have spawned in the *current year* absent fisheries, as distinguished from adult equivalent (AEQ) units which are the number that would have spawned in the *current or future years* absent fisheries.

S_a is the annual survival rate absent fisheries, m_a is the maturation rate, and w_a is the out-of-basin stray rate.

For the fixed-cap alternatives, the total number of impacts (all fisheries) of natural area destined fish in spawner equivalent units is

$$I^{\mathrm{F}}_{n\text{-SE}} = \sum_{a=3}^{5}((I_{o,a} \times p_{o,a}) + I_{r,a} + I_{t,a}) \times g_a, \tag{0.14}$$

where $I_{o,a}, I_{r,a}$, and $I_{t,a}$ are the impacts of the ocean (*o*), river recreational (*r*), and river tribal (*t*) fishery, respectively, and $p_{o,a}$ is the proportion of the $I_{o,a}$ that would have spawned at age *a* absent fisheries:

$$p_{o,a} = \sum_{\tau=\mathrm{Sept}}^{\mathrm{Aug}} I_{o,a,\tau} \times S_{a,\tau} \times m_a \times (1 - w_a) / I_{o,a}; \tag{0.15}$$

$I_{o,a,\tau}$ is the ocean age *a* impacts in month $\tau = \{\text{Sept, Oct, ..., Aug}\}$, and $S_{a,\tau}$ is the age *a* survival rate absent fisheries from month τ through the end of August (just prior to maturation). Under the fixed-cap alternatives, $I_{o,4}$ is constrained such that $I_{o,4} / N_4 \leq i^{\mathrm{F}}_{o,4}$; the ocean age-4 impact rate cap, and the $\{I_{o,a,\tau}\}, \{I_{r,a}\}$, and $\{I_{t,a}\}$ are forecast by the KOHM subject to the $i^{\mathrm{F}}_{o,4}$ constraint and the user group harvest allocations. Note that while the tribal harvest allocation is annually fixed at 50% of the total allowable harvest, the river sport allocation is not determined by the PFMC—it is annually specified by the California Fish and Game Commission.

For each alternative A ={Q,S,F}, the spawner reduction rate (SRR) due to fishing is

$$SRR = 1 - E^{\mathrm{A}}_n / E^0_n. \tag{0.16}$$

Hindcast Analysis of Escapement Goals and Spawner Reduction Rates Under the De Minimis Fishery Alternatives Over the 1985-2006 Period

For the purpose of hindcasting, additional formulas consistent with the KOHM are presented below that allow one to approximate the annual escapement goal and spawner reduction rate under each of the *de minimis* fishery alternatives were they in effect during the 1985–2006 period.

For the ocean fishery:

$$I_{o,a} = N_a \times i_{o,4} \times v_{o,a} \quad \text{, where } v_{o,a} = i_{o,a} / i_{o,4}, \tag{0.17}$$

with $v_{o,a}$ denoting the ocean impact rate at age *a* relative to the age-4 rate. The ocean harvest total (H_o) may be expressed in terms of the $\{I_{o,a}\}$ and the age-specific harvest rate / impact rate ratios ($q_{o,a}$) as

$$H_o = \sum_{a=3}^{5} I_{o,a} \times q_{o,a} \quad \text{, where } q_{o,a} = h_{o,a} / i_{o,a} \text{ ,} \tag{0.18}$$

and $h_{o,a} = H_{o,a} / N_a$ is the ocean age *a* harvest rate.

For the river fisheries:

$$H_r = H_o \times \pi_r /(1-\pi_r) \quad , \quad H_t = H_o \times \pi_t /[(1-\pi_t)(1-\pi_r)], \tag{0.19}$$

where π_r is the proportion of the nontribal harvest allocated to the recreational fishery (H_r), and π_t is the proportion of the total harvest allocated to the tribal fishery (H_t). The age-specific river harvests are

$$H_{r,a} = H_r \times u_{r,a} \quad , \quad H_{t,a} = H_t \times u_{t,a}, \tag{0.20}$$

where $\{u_{r,a}\}$ and $\{u_{t,a}\}$ is the age-composition of the respective harvests, which depends on the age-specific abundances of the river run $\{R_a\}$ and on the gear selectivity of the respective fisheries:

$$u_{r,a} = \frac{R_a \times v_{r,a}}{\sum_{a=3}^{5} R_a \times v_{r,a}} \quad , \quad u_{t,a} = \frac{R_a \times v_{t,a}}{\sum_{a=3}^{5} R_a \times v_{t,a}}, \tag{0.21}$$

where the selectivity coefficients $\{v_{r,a}\}$ and $\{v_{t,a}\}$ are relative to the selectivity at age-4, and

$$R_a = R_a^0 - (I_{o,a} \times p_{o,a}). \tag{0.22}$$

Finally, the respective age-specific impacts are

$$I_{r,a} = H_{r,a} /(1-d_r) \quad , \quad I_{t,a} = H_{t,a} /(1-d_t), \tag{0.23}$$

with dropoff mortality rate values of $d_r = 0.02$ and $d_t = 0.08$.

Hindcast Methods:

For each year in the 1985–2006 period, the above formulas were applied to the yearly age-specific pre-season ocean abundance forecasts $\{\hat{N}_a\}$ to determine the yearly escapement goal and spawner reduction rate under each of the de minimis fishery alternatives were they in effect during this period. Values for several of the parameters in these formulas were not readily available for the 1985–2001 period, and for these years the average value of the parameters over the 2002–2006 period (Table 2) was used for the analysis. Harvest allocations of $\pi_r = 0.15$ and $\pi_t = 0.50$ (the norm values) were assumed for all years in the analysis. These simplifications should provide reasonably good approximations for the present purpose. Below, we superscript the formula-derived quantities by a "*".

For the status quo and sliding scale alternatives:

1. E_n^{0*} was calculated according to equations (1.4) and (1.5) using $\{\hat{N}_a\}$ and the Table 2 quantities.
2. $E_n^{\mathrm{Q}*}$ and $E_n^{\mathrm{S}*}$ were determined by equations (1.1) and (1.2).
3. $SRR_n^{\mathrm{Q}*}$ and $SRR_n^{\mathrm{S}*}$ were calculated by equation (1.8).

For the fixed-cap alternatives:

1. E_n^{0*} and $\{R_a^{0*}\}$ were calculated according to equations (1.4) and (1.5) using $\{\hat{N}_a\}$ and the Table 2 quantities.
2. $\{I_{o,a}^*\}$ and H_o^* were calculated according to equations (1.9) and (1.10) using $\{\hat{N}_a\}$, the alternative's $i_{o,4}^{\mathrm{F}}$ cap, and the Table 2 quantities.
3. $\{I_{r,a}^*\}$ and $\{I_{t,a}^*\}$ were calculated according to equations (1.11–1.15) and using $\{\hat{N}_a\}$, $\{R_a^{0*}\}$, $\{I_{o,a}^*\}$, H_o^*, and the Table 2 quantities.
4. $I_{n\text{-SE}}^{\mathrm{F}*}$ was calculated by equation (1.6).
5. $E_n^{\mathrm{F}*}$ was determined by equations (1.3) and (1.1).
6. $SRR_n^{\mathrm{F}*}$ was calculated by equation (1.8).

For a particular year, $I_{n\text{-SE}}^{\mathrm{F}*}$ will be nearly proportional to $i_{o,4}^{\mathrm{F}}$ in this analysis owing to the linear nature of equations (1.4-1.15). (The $\{I_{o,a}\}$, I_r, and I_t are proportional to $i_{o,4}^{\mathrm{F}}$, but $\{I_{r,a}\}$ and $\{I_{t,a}\}$ are not because of the dependence of $\{u_{r,a}\}$ and $\{u_{t,a}\}$ on $\{R_a\}$ which is not proportional to $i_{o,4}^{\mathrm{F}}$.)

It is important to note that this analysis is *static*. It does not account for the reduction in the following year's preseason ocean abundance from the (hypothetical) implementation of de minimis fisheries (i.e. doesn't account for cohort carryover effects). Similarly, it does not account for changes to preseason ocean abundance in future years due to any changes in recruitment associated with the reduced number of spawners under *de minimis* fisheries.

Table E-1. Notation used in the hindcast analysis.

Symbol	*Description*
0	Superscript denoting "absent fisheries"
a	Subscript denoting age, $a \in \{3,4,5\}$
A	Superscript denoting de minimis alternative, $A \in \{F,Q,S\}$
F	Fixed cap
Q	Status quo
S	Sliding scale
d	Dropoff mortality rate (dropoff mortality / impacts)
E_n	Escapement in natural areas
g	Proportion of spawners destined for natural areas
H	Harvest rate
$\mathcal{H}$	Harvest
I	Impact rate
$\mathcal{I}$	Impacts (harvest, hook-and-release, dropoff)
$I_{n\text{-SE}}$	Impacts of natural area destined fish in spawner equivalent units
k	Subscript denoting fishery sector, $k \in \{o,r,t\}$
o	Ocean
r	River recreational
t	River tribal
m	Maturation rate
$\mathcal{N}$	Preseason ocean abundance
p	Proportion of impacts that would have spawned in current year absent fisheries
π_r	Proportion of nontribal harvest taken by river recreational fishery
π_t	Proportion of total harvest taken by river tribal fishery
q	Ratio: harvest rate / impact rate
$\mathcal{R}$	River run abundance
S_a	Survival rate absent fisheries, age a
$S_{a,t}$	Survival rate absent fisheries, age a, month τ through Aug
$\mathcal{SRR}$	Spawner reduction rate due to fisheries
τ	Subscript denoting month, $\tau \in$ {Sept, Oct, …, Aug}
u	Harvest age composition (proportion at age)
v	Vulnerability relative to age-4
w	Out-of-basin stray rate

Table E-2. Parameters values used in hindcast analysis. The 2002–2006 values were taken from the KOHM adopted by the PFMC in those years, respectively.

Quantity	*2002*	*2003*	*2004*	*2005*	*2006*	**Average**
S_3	0.5848	0.5848	0.5848	0.5848	0.5848	0.5848
S_4	0.8	0.8	0.8	0.8	0.8	0.8
S_5	0.8	0.8	0.8	0.8	0.8	0.8
m_3	0.3747	0.3790	0.3806	0.3784	0.3815	0.3788
m_4	0.8809	0.8828	0.8882	0.8814	0.8812	0.8829
m_5	1.0	1.0	1.0	1.0	1.0	1.0
w_3	0.0057	0.0055	0.0052	0.0054	0.0063	0.0056
w_4	0.0038	0.0037	0.0035	0.0035	0.0046	0.0038
w_5	0.0029	0.0090	0.0085	0.0082	0.0090	0.0075
$p_{o,3}$	0.3586	0.3614	0.3637	0.3564	0.3650	0.3610
$p_{o,4}$	0.8249	0.8055	0.8075	0.7715	0.7518	0.7922
$p_{o,5}$	0.9151	0.8932	0.8316	0.8520	0.7951	0.8574
g_3	0.62	0.46	0.55	0.538	0.672	0.568
g_4	0.61	0.71	0.61	0.545	0.552	0.605
g_5	0.65	0.69	0.71	0.717	0.723	0.698
$v_{o,3}$	0. 3796	0.3071	0.2870	0.1957	0.1664	0.2672
$v_{o,4}$	1.0	1.0	1.0	1.0	1.0	1.0
$v_{o,5}$	1.1641	1.1562	2.2598	1.3770	6.6171	1.3770*
$q_{o,3}$	0.9110	0.8883	0.8637	0.8411	0.8442	0.8697
$q_{o,4}$	0.9437	0.9270	0.9099	0.8582	0.8305	0.8939
$q_{o,5}$	0.9511	0.9509	0.9432	0.9356	0.9225	0.9407
$v_{r,3}$	1.4	1.4	1.35	1.359	1.406	1.383
$v_{r,4}$	1.0	1.0	1.0	1.0	1.0	1.0
$v_{r,5}$	1.0	1.0	0.93	0.929	0.914	0.955
$v_{t,3}$	0.5	0.5	0.49	0.481	0.489	0.492
$v_{t,4}$	1.0	1.0	1.0	1.0	1.0	1.0
$v_{t,5}$	1.7	1.7	1.63	1.626	1.570	1.645

* Median.

APPENDIX F: CARRY-OVER EFFECT OF 16% CAP ALTERNATIVE.

The hindcast analysis was static in part because the effect of reduced stock size due to *de minimis* fishing was not evaluated relative to impacts on future recruitment. *De minimis* fishing also affects age-3 and age-4 fish that would carry-over in the ocean for one or two more summers. The effect of the 16% Cap Alternative on carry-over of age-3 and age-4 KRFC was analyzed based on the ocean survival probability of the 16% Cap Alternative compared to the Status Quo Alternative.

The 16% Cap Alternative is the most liberal of the Council's *de minimis* fishery alternatives, and the relative impact of the other *de minimis* fishing alternatives on ocean carry-over of age-3 and age-4 KRFC can be inferred from the following results.

Methods

The approach used was to estimate (adjust) ocean abundance levels in years following the implementation of the 16% Cap Alternative, which were analyzed in the text in Section 4.1.2. The formulas were:

N(t).4.adj = N(t).4.pre * [1-i(A,t-1*.20)] / [1-i(SQ,t-1*.20)].

N(t).5.adj = N(t).5.pre. * { [1-i(A,t-2*.20)] / [1-i(SQ,t-2*.20)] } * { [1-i(A,t-1)] / 1-i(SQ,t-1)] }

where,

N(t).4.pre and N(t).5.pre are the year t preseason forecasts of record,
i(A,t) is the age-4 ocean impact rate in year t under alternative A (16% Cap in this case), and
i(SQ,t) is the age-4 ocean impact rate in year t under status quo management, which was assumed to be 0.4 x the status quo spawner reduction rate. Both of these harvest rates were reduced by 80% to account for the lower vulnerability and smaller size of age-3 fish compared to age-4 fish. No adjustment was applied for fish carrying over from age-4 to age-5

The above ratios approximate the reduction in ocean survival with the 16% Cap Alternative compared to Status Quo. The Rebuilding Alternative which precludes further *de minimis* fishing after three successive years of failure to meet the natural adult spawner floor was not applied to this analysis.

Results

Implementation of the 16% Cap had a slight ripple effect in the ocean population sizes of age-4 and age-5 fish, which affected 13 (59%) of the 22 years in the series. The differences between unadjusted (static) and adjusted ocean population sizes over the entire series were small: 0.4% reduction in ocean population size of age-4 fish and 1.2% of age-5 fish. Abundance of natural spawners in the absence of fishing for the entire series declined by an average of 200 fish per year (0.2%). Considering only the years affected by *de minimis* fishery carry-over effect, the population size reductions were higher at 1.1% for age-4 fish and 3.9% for age-5 fish. The reduction in natural run size in the absence of fishing in carry-over years was 0.4% (Table F-1).

Table F-1. Ocean abundance and natural spawner projections for hindcast analysis, 1985-2006 (thousands) showing unadjusted (static) and adjusted population levels under the status quo and 16% Cap alternatives.

	Ocean Abundance							No fishing natural spawners (static)	No fishing natural spawners (adjusted)
Season	Age-3	Age-4 (static)	Age-4 (adjusted)	Age-5 (static)	Age-5 (adjusted)	Total (static)	Total (adjusted)		
1985	113.0	56.9	56.9	0.0	0.0	169.9	169.9	38.4	38.4
1986	426.0	66.3	64.6	0.0	0.0	492.3	490.6	81.5	80.8
1987	511.8	206.1	206.1	5.3	5.2	723.2	723.1	154.8	154.7
1988	370.8	186.4	186.4	13.3	13.3	570.4	570.5	133.1	133.2
1989	450.6	215.5	215.5	10.1	10.1	676.2	676.2	153.8	153.8
1990	479.0	50.1	50.1	7.6	7.6	536.8	536.7	85.5	85.5
1991	176.2	44.6	44.6	1.5	1.5	222.3	222.3	41.9	41.9
1992	50.0	44.8	43.9	1.3	1.2	96.0	95.1	26.0	25.6
1993	294.4	39.1	37.8	1.1	0.9	334.6	333.2	54.1	53.5
1994	138.0	86.1	85.8	0.5	0.5	224.6	224.2	54.2	54.1
1995	269.0	47.0	46.8	2.0	2.0	318.0	317.8	54.8	54.7
1996	479.8	268.5	267.6	1.1	1.1	749.4	748.5	175.0	174.6
1997	224.6	53.9	53.9	7.9	7.9	286.4	286.4	55.4	55.4
1998	176.0	46.0	45.9	3.3	3.3	225.3	225.2	43.4	43.4
1999	84.8	78.8	77.5	2.0	1.8	165.6	164.1	45.3	44.6
2000	349.6	38.9	38.4	1.4	1.3	389.9	389.2	61.1	60.8
2001	187.2	247.0	247.0	1.3	1.2	435.5	435.4	129.3	129.3
2002	209.0	143.8	143.8	9.7	9.7	362.5	362.5	94.8	94.8
2003	171.3	132.4	132.4	6.5	6.5	310.2	310.2	87.1	87.1
2004	72.1	134.5	134.5	9.7	9.7	216.3	216.3	72.3	72.3
2005	185.7	48.9	48.9	5.2	5.2	239.8	239.8	43.7	43.7
2006	44.1	63.7	62.7	2.2	2.0	110.0	108.8	32.5	32.0
All yrs (avg):		104.5	104.1	4.2	4.2	357.1	356.6	78.1	77.9
Static/adjusted:			1.004		1.012		1.001		1.002
Carry-over yrs (avg)		77.9	77.1	2.3	2.2			74.4	74.1
Static/adjusted:			1.011		1.039				1.004

The adjusted ocean population sizes did not change the years or frequency of implementation of the 16% Cap Alternative based on the hindcast analysis years of 1985-2006. The average natural escapement projection declined by about 100 fish (0.4%) compared to the unadjusted population projections. The natural escapement declined 200-300 fish (1%) in the very low abundance years of 1992 and 1999 (Table F-2). The spawner reduction rates for the adjusted population projections are shown in Table F-3.

Table F-2. Escapement projections to natural areas under unadjusted and adjusted status quo and 16% Cap alternatives, 1985-2006 (thousands). Seasons with no change in projections are omitted from the table for clarification. The actual SRRs are shown in Table D-3.

	Status quo		16% Cap		
Season	Unadjusted	Adjusted	Unadjusted	Adjusted	Diff
1985	35.0	35.0	22.3	22.3	0.00
1986	35.0	35.0	51.1	50.8	
1987	51.6	51.6	89.4	89.3	
1988	44.4	44.4	72.5	72.6	
1989	51.3	51.3	86.0	86.0	
1990	35.0	35.0	51.7	51.7	
1991	35.0	35.0	24.9	24.9	0.00
1992	26.0	25.6	14.2	14.0	0.01
1993	35.0	35.0	33.8	33.5	0.01
1994	35.0	35.0	30.9	30.9	0.00
1995	35.0	35.0	33.4	33.3	0.00
1996	58.3	58.2	100.7	100.5	
1997	35.0	35.0	30.8	30.8	0.00
1998	35.0	35.0	25.1	25.1	0.00
1999	35.0	35.0	24.7	24.4	0.01
2000	35.0	35.0	38.5	38.3	
2001	43.1	43.1	70.9	71.0	
2002	35.0	35.0	47.9	47.9	
2003	35.0	35.0	45.7	45.6	
2004	35.0	35.0	36.0	36.0	
2005	35.0	35.0	28.3	28.3	0.00
2006	32.5	32.0	17.0	17.0	0.00
avg=	31.1	31.1	23.8	23.7	0.00

Table F-3. Spawner reduction rates for unadjusted and adjusted status quo and 16% Cap alternatives, 1985-2006 seasons.

	Status quo		16% Cap	
Season	Unadjusted	Adjusted	Unadjusted	Adjusted
1985	8.8%	8.8%	41.8%	41.9%
1986	57.1%	56.7%	57.1%	56.7%
1987	66.7%	66.7%	66.7%	66.7%
1988	66.7%	66.7%	66.7%	66.7%
1989	66.7%	66.7%	66.7%	66.7%
1990	59.1%	59.1%	59.1%	59.1%
1991	16.4%	16.4%	40.5%	40.6%
1992	0.0%	0.0%	45.5%	46.1%
1993	35.3%	31.8%	37.5%	38.0%
1994	35.5%	34.4%	43.0%	43.1%
1995	36.1%	35.6%	39.1%	39.2%
1996	66.7%	66.7%	66.7%	66.7%
1997	36.8%	36.8%	44.4%	44.4%
1998	19.4%	18.8%	42.1%	42.2%
1999	22.7%	17.0%	45.4%	46.1%
2000	42.7%	41.4%	42.7%	41.4%
2001	66.7%	66.7%	66.7%	66.7%
2002	63.1%	63.1%	63.1%	63.1%
2003	59.8%	59.8%	59.8%	59.8%
2004	51.6%	51.6%	51.6%	51.6%
2005	19.9%	19.9%	35.3%	35.3%
2006	0.0%	0.0%	47.5%	47.7%

APPENDIX G: BIOLOGICAL ANALYSIS OF POPULATION AND FISHERY EFFECTS OF DE MINIMIS FISHERIES FOR KLAMATH FALL CHINOOK

October 17, 2006

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Summary

This biological analysis projected the effects of *de minimis* fishery implementation at various levels on future population size and fishery harvest. The key question is whether the effects of low fishing rates in low run years on spawning escapement significantly affects future numbers. Projections were based on a Population Viability Analysis (PVA) using a stochastic, age-structured, stock-recruitment population model (SSRM). A population viability analysis is conceptually the same approach that has been applied to the identification of take limitations based on impact levels deemed to pose no jeopardy to future viability for listed salmon stocks under the ESA. The model is an adaptation of the model previously used by Prager and Mohr (2001) to evaluate the effects of fishery alternatives.

The model estimates annual fish numbers, harvest, and fishery impacts based on fishery strategies including the historical Salmon Fishery Management Plan (FMP), the Status Quo, and alternative *de minimis* fishing rates. The fish population portion of the model estimates age-specific numbers of natural and hatchery-produced fish in the ocean, returning to the river, and escaping fisheries to return to natural spawning areas or hatcheries. The fishery portion of the model estimates encounter, harvest, and impact numbers and rates for ocean troll, ocean recreational, river (Tribal) net, and river recreational fisheries. The model is configured using historical Klamath Fall Chinook data on natural and hatchery production, survival, and maturation rates. Variability in fish population and fishery dynamics is incorporated into stochastic simulations with multiple iterations (e.g., 200) of a 40 year period beginning with current conditions. The model is built in Excel using Visual Basic. The current calibration of the model produces outputs that closely match historical averages and ranges of fish numbers and harvest in the ocean and the river.

The modeling confirms that future long-term effects of low fishing rates on escapement and harvest are relatively small and lost in the normal real world variability in the system. Conclusions are the same as those previously reported by Prager and Mohr (2001) using a similar modeling approach. The model estimates a 27% frequency of escapements of less than 35,000 under current management (35,000 spawner floor and an ESA limit on ocean fishery harvest rates of less than 16% for age-4 fish). Escapements regularly fall under the floor due normal variation in productivity and uncertain fishery forecasts and catchability. *De minimis* fisheries would occur in 15% of years at rates of 5% or less and up to 24% of years at an impact rate of 13%. *De minimis* fishing rates of 5%, 10%, and 13% increase the absolute value of low run size risks by 1.3%, 3.4%, and 4.9% respectively. Frequencies of 3 consecutive years of escapements less than 35,000 (Overfishing Concern)are little affected by *de minimis* fisheries under 13%. Average harvest and escapement of Klamath fall Chinook are little affected by the implementation of *de minimis* fisheries of 13% less. Sensitivity analyses to different combinations of input parameters confirm that the relative effects of *de minimis* fishing rates are consistent among different parameterizations of the model.

This biological analysis evaluates the effects of fishing on the Klamath Fall Chinook population and fishery but does not directly consider the effects of Klamath fall Chinook harvest constraints on the much larger catches of other California and Oregon Chinook stocks in ocean fisheries. These results will inform policy decisions on appropriate fishing strategies, however, acceptable levels of effect and risk will remain a policy decision.

Summary of Model Revisions

Based on technical review comments received on SSRM Version 1 reported in the 9/1/06 draft of this report, a series of revisions were included in SSRM Version 2. These included:

1. The model was revised to more realistically reflect fishery management practices and their effects on fishery implementation error by accounting for errors in preseason stock forecast, basing fishery targets on forecast rather than actual numbers, tracking actual and forecast numbers from ocean abundance through the fisheries, and capturing effects on in river harvests. Version 1 of the model estimated ocean fishing rates based on actual ocean abundance with an input variance on the ocean fishing rate. Target fishing rates were randomly varied to produce a pattern equivalent to that observed in comparisons of target and actual fishing rates in post season analyses. In-river tribal harvests were selected by the model to meet the management intent (50% of the harvest). This version of the model produced a realistic distribution of ocean fishery implementation variances but consistently overestimated the tribal harvest and harvest share. In actual practice, in-river fisheries are regulated for quotas based on forecast rather than actual numbers. However, ocean fisheries are regulated by open days, hence, can catch proportionately more fish in larger-than-forecast years. As a result, the in-river tribal fishery consistently fails to achieve a 50% harvest share in years where forecasts are less than the actual numbers. In Version 2, target ocean fishing rates were based on forecast rather than actual numbers with forecast error based on historical variances. The target rates were used to estimate ocean fishery contact rates. However, these contact rates were then applied to actual rather than forecast numbers to reflect the reality of ocean fishery implementation. An ocean fishery implementation error was applied in addition to the forecast error effects. In-river harvests were based on forecast rather than actual numbers with no opportunity to increase or decrease harvest based on actual river returns in years where the forecast was in error. This change resulted in a reduction in modeled tribal harvest and harvest shares relative to previous simulations. As a result, escapement numbers increased and risks of low escapements decreased slightly. However, the pattern of effects of *de minimis* fishing rates was similar in both sets of simulations.

2. Autocorrelation in the relationship between target and actual fishing rates was also included in the model based on the observed correlated between forecast error and stock-recruitment variance. Ocean abundance was typically over forecast in years of less than expected recruits per spawners and under forecast in years of greater than expected recruits per spawner. The effect of this change was to slightly increase risks of low escapements at any given fishing level due to the compounding effects of forecast and stock-recruit errors. Thus, the effects of this change partially offset the effects of a more realistic representation of in-river harvest dynamics.

3. Additional constraints on the in-river sport fishery were included to realistically reflect the capacity of that fishery. Harvest was capped at 20,000 fish which is the greatest observed in the historical dataset. At projected harvests of less than 20,000, the sport fishery harvest was determined by harvest-share-related contact rates and forecast in-river abundance. In conjunction with this change, the impacts transfer routine of the model was configured to ensure that ocean fishery impacts in years of a 16% ESA constraint on ocean fisheries were effectively transferred to the in river sport fishery up to prescribed limits. (Thus, in some years the entire impact could not be absorbed by the sport fishery whereupon it was passed to escapement.)

4. The frequency of occurrence of small population-specific escapements was incorporated into the model to address a concern regarding the potential effects of *de minimis* fisheries on substock structure. This analysis was developed by LaVoy, Mohr, and others as an addendum to the SSRM and is described in detail in a separate appendix.

5. Version 2 simulations of future expectations were also run assuming no consistent bias in ocean fishery implementation errors. Recall that historical fishery implementation resulted in actual ocean harvest rates of Klamath fall Chinook that averaged 40% greater than the target rates (30% where

based on a geometric rather than an arithmetic mean to reflect the non-normal error distribution.) The initial round of simulation results projected this bias into the future. However, review comments indicated that changes in ocean fishery management models and practices were expected to eliminate this bias.

6. Based on technical comments, the natural spawning hatchery fraction was increased from 5% to 10%. The available data on natural spawning by hatchery fish is not complete in all areas of the Klamath basin but the assumed rate was doubled based on expert opinions.

7. Additional summary statistics were included to track the effects of fishing alternatives. The model was revised to track the frequency of "Overfishing Concerns" as defined in PFMC regulatory language. The model was also revised to calculate average abundance and harvest numbers in the years where *de minimis* fisheries were implemented. These were particularly useful in considering the economic benefits of *de minimis* fisheries relative in years where no fishery would otherwise occur.

8. Finally, an additional series of sensitivity analyses were completed as per technical review comments to explore the effects of differences in input parameters on model-predicted effects of *de minimis* fishing alternatives.

Introduction

The report describes methods and results of analyses of the effects of *De minimis* fishing levels on Klamath fall Chinook numbers and fisheries based on simulations with a stochastic stock recruitment model (SSRM). The objective of the analysis is to identify *de minimis* fishing levels that provides for limited fishing opportunities in low return years without significantly affecting future fish numbers.

De minimis is Latin for "of minimum importance" or "trifling." Essentially it refers to something or a difference that is so little, small, minuscule, or tiny that effects need not be considered. This is conceptually the same approach that has been applied to the identification of take limitations for listed salmon stocks under the ESA. Take limitations are based on impact levels deemed to pose no jeopardy to future viability. *De minimus* fishing levels are intended to provide management flexibility for shaping mixed stock fisheries to optimize access to strong runs while minimizing impacts on weak runs. Effective application will ensure the ability of depressed stocks to sustain MSY in the long term while avoiding a level of fishery restrictions that can lead to severe economic consequences to local communities.

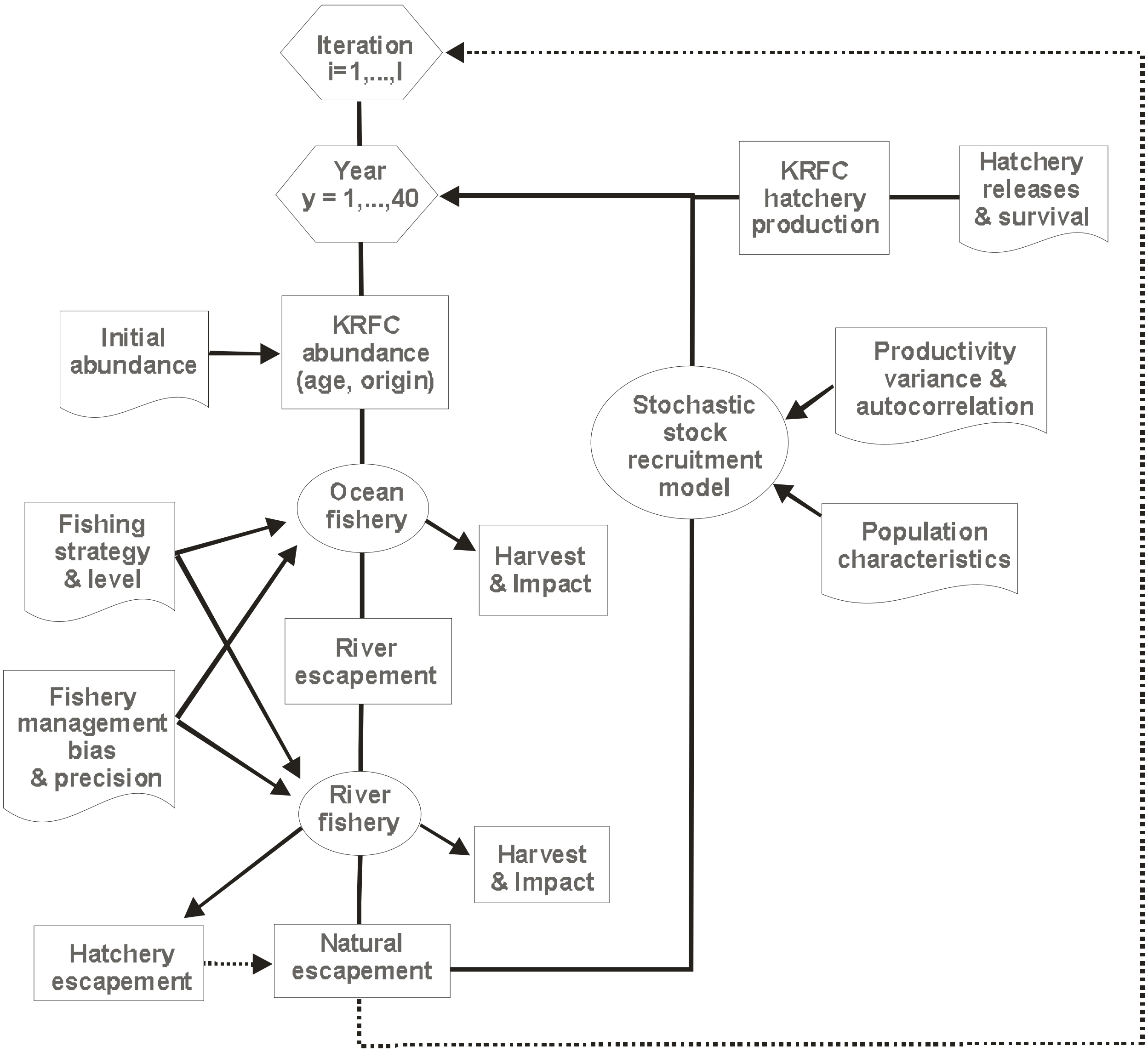
Methods

Model Description

The model estimates annual fish numbers, harvest, and fishery impacts based on various fishery strategies including the historical FMP, the Status Quo, and alternative *de minimis* fishing rates. The fish population portion of the model estimates age-specific numbers of natural and hatchery-produced fish in the ocean, returning to the river, and escaping fisheries to return to natural spawning areas or hatcheries. The fishery portion of the model represents fisheries in the ocean (all areas aggregated) and in the Klamath River system (ocean troll, ocean recreational, river tribal, and river recreational). Fishery variables include encounter, harvest, and impact numbers and rates. The model is configured using historical Klamath Fall Chinook data on natural and hatchery production, survival, and maturation rates. Fishery parameters include age and fishery-specific vulnerabilities, legal fractions, catch-and-release mortality rate, and drop-off mortality rate, as well as the prescribed allocation of harvest among fisheries.

The model couples fishery dynamics with a Ricker stock-recruitment function in a stochastic framework. A stochastic approach allows explicit analysis of conservation and future fishery risks associated with fishing at low population levels. The model includes uncertainty and variability in both fish population and fishery dynamics. Stochastic simulations involve multiple iterations (e.g., 500) of a 40 year time interval beginning with current conditions. The 40 year period was based on the spawning escapement policy for Klamath River Fall Chinook (KRTT 1986). Results are expressed in terms of averages, variances, ranges, and frequency distributions. Risks were expressed based on probabilities of various outcomes (e.g., probability of future spawning escapement of less than 35,000 fish in any one year).

The essential formulation of the model is depicted in Appendix FigureG-1. The model is built in Excel using Visual Basic. A simple interface page facilitates model use and review of results. Fishery alternatives and inputs are configured to allow for simulation of different combinations and easy examination of results in statistical and graphical format. A more detailed description and discussion of the model formulation and results may be found in Sub-Appendix b.



Appendix FigureG-1. Model algorithm.

Fishery Alternatives

The model simulates the effects of fishery strategies identified as inputs by the user. Strategies are defined primarily based on the ocean fishery. Fishing rates consistent with each strategy are input as an ocean age-4 fishery impact rate unless otherwise identified. Fishery impacts include direct and indirect fishery mortalities from harvest, catch and release, and drop-off. In river fisheries are scaled to match ocean fisheries according to current legal requirements for tribal:non-tribal shares and Council policies or actions relative to non-tribal shares. Alternatives include:

<u>Fixed rate</u>.– A simple fixed fishing rate is included as a model option. This rate applies in all years regardless of fish abundance. This strategy was used for model development and calibration purposes, to represent reference values in the absence of fisheries, and to determine an impact rate that produces an 80% probability of meeting the 35,000 spawner goal.

Fishery Management Plan.– The FMP provides a baseline point of comparison representative of historical fishing patterns. For this option, the model calculates a fishing rate that takes all fish in excess of a prescribed natural spawning escapement floor (35,000) unless the spawner reduction rate is projected to exceed 67%, whereupon a fishing rate is selected to produce a 67% spawner reduction rate. Spawner reduction rate is defined as the proportional reduction in escapement relative to that projected in the absence of fishing. Under the FMP alternative, no fisheries would occur in years of projected spawner escapements less than the spawner floor. The FMP is implemented based on annual ocean abundance forecasts.

De minimis fishing rate.– A *de minimis* fishing rate strategy operates the same as the fishery management plan except that no fisheries occur in years of projected spawner escapements less than the spawner floor at a prescribed fishing rate (e.g., 5%, 10%, 13%). Fishing rate inputs for this option are defined as an ocean age-4 fishery impact rate.

ESA constraint.– The ESA constraint may be used to cap the ocean fishery impact at a prescribed rate (e.g., the 17% impact equivalent of a 16% ocean harvest rate identified for California Coastal Chinook). This input works independent of other model fishery alternatives so that it can be used in combination with any alternative. As per management practice, Klamath fall Chinook inputs foregone by ocean fisheries are transferred to the river sport fishery up to harvest number and rate limits based on the maximums observed in the historical dataset.

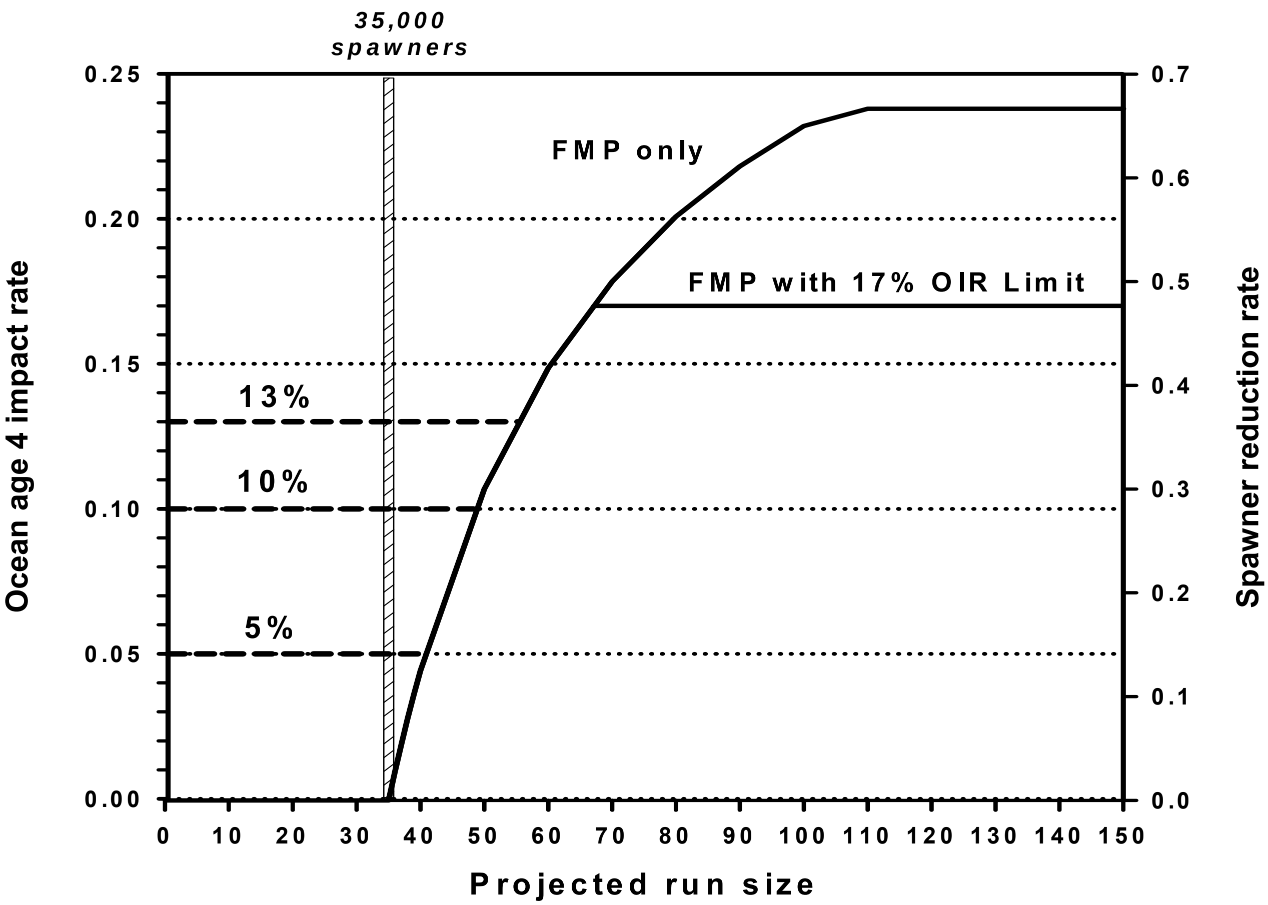


Figure G-2. Fishery alternatives represented in terms of spawner reduction rate and ocean age-4 impact rate. Relationship between spawner reduction rate and ocean age-4 impacts is an average based on fishery parameters, allocation among fisheries, and average age composition of the run.

Model Variables and Parameters

A full list of model inputs may be found in Table G-1. Descriptions of derivation and application of model variables and inputs are as follows:

Table G-1. Example model input parameters used for calibration simulations of past management practices (from model input page).

Population

Iterations	200	
print all (0= no, 1 = yes)	1	
Initial population size (spnrs)		
2 years ago	24,100	
1 year ago	27,300	
Yr 1 ocean recruits	total #	p Hatch
age 3	44,100	0.67
age 4	63,700	0.55
age 5	2,200	0.72
Stock Recruitment Function		
alpha	14.87	
beta	1.787E-05	
spawners @ max constraint	162,000	
max recruits constraint	777,000	
Depensation (0=no, 1=yes)	1	
theshold escapement	35000	
Recr variation (ocean)	2	
0 = deterministic		
1 = random (log) normal	MSE :	0.91
2 = random autocorrelated	coef:	0.5
Freshwater production trend	0	
Age-specific maturity rate		
Age 3	0.379	
Age 4	0.883	
Age 5	1.000	
Ocean winter survival rate		
age 3	0.58	
age 4	0.8	
age 5	0.8	
Hatchery fish		
Annual releases (millions)	8.9	
SAR	0.007	
p natural spawning	0.1	
egg take goal (millions)	16	
eggs/spawner	1,250	

Fishery

Fishing strategy	2	ref rate	ref esc	other
1 = fixed rate		0.000		
2 = Fish Management Plan		0.67	35000	
3 = de min (fixed)		0		
Rebuilding? (0 or 1)	0			
ESA Limit? (0 or 1)	1			
max impact		0.17		
transfer harv?		1		
River sport limitations				
max harv rate		0.12		
max catch		20,000		
Forecast uncertainty	var	corr		
age 3	0.5	-0.5		
age 4	0.4			
age 5	1.2			
Implementation uncertainty				
CV	0.5			
Bias	1.3			
Fishery allocation				
ocean troll	0.3400			
ocean recreational	0.0850			
river tribal	0.5000			
river recreational	0.0750			
Ocean troll	**vulner**	**legal**	**C&R**	
age 3	0.25	0.80	0.26	
age 4	1.00	0.95	0.26	
age 5	2.00	1.00	0.26	
dropoff mort rate				0.05
Ocean recreational	**vulner**	**legal**	**C&R**	
age 3	0.50	0.99	0.14	
age 4	1.00	1	0.14	
age 5	2.00	1	0.14	
dropoff mort rate				0.05
RiverTribal	**vulner**	**retain**	**C&R**	
age 3	0.50	1	0	
age 4	1.00	1	0	
age 5	1.60	1	0	
dropoff mort rate				0.08
River recreational	**vulner**	**retain**	**C&R**	
age 3	1.40	1	0	
age 4	1	1	0	
age 5	0.95	1	0	
dropoff mort rate				0.02

Fishing rates.– Annual fishing rates were estimated in the model based on the designated fishing strategy and annual forecasts of fish available. The model uses different routines to identify a target fishing rate in each year for each fishery depending on the fishing strategy. Input fishing rates are typically entered as an ocean age-4 impact rate. The model uses ocean age-4 impact rates as a key metric for describing and scaling fisheries consistent with current management practice. Impacts include harvest, catch-release, and drop-off mortalities. The model scales fishery contact rates, harvest rates, and impact rates for each fishery to produce the desired net impact or spawner reduction rate based on fishery allocation goals, age-specific fishery parameters, and preseason forecasts of age-specific fish numbers. Fishery allocations among ocean troll, ocean recreational, river tribal, and river recreational fisheries are a user input. Fishery parameters include vulnerability, proportion of catch that is retained, catch-release mortality rate, and drop-off mortality rate. The fishery formulations are similar to those in the KOHM annual fishery management model, although parameters in the SSRM are annual rather than month or area numbers. Fishery parameters are described in greater detail in Mohr et al. (2001) and Prager and Mohr (1999, 2001).

Fishery Variance.– Actual fishery impacts vary relative to target values due to the effects of uncertain forecasts and normal variation in effort and catch rates. The model included separate variance terms to capture the effects of 1) forecast error and 2) fishery variance.

Forecast errors were estimated based on the difference between preseason and postseason estimates of ocean abundance by age (Figure G-3). Annual forecast errors were not correlated among ages (Table G-2). However, age-3 forecast efforts were highly correlated with stock-recruitment function residuals for the brood year (Figure G-4). Model simulations included independent estimates of forecast error for each age with the age-3 forecast error related to the stock-recruitment residual error for the same brood year.

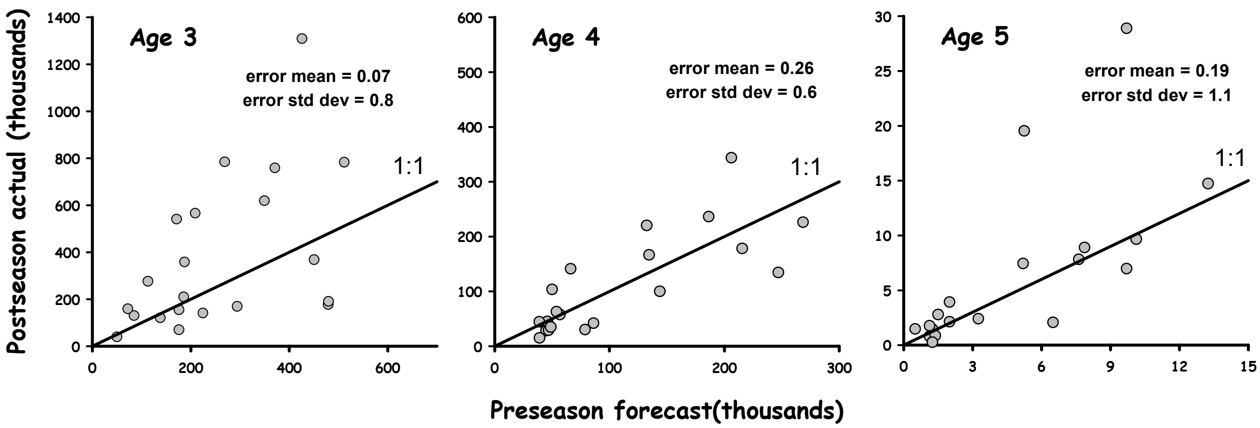
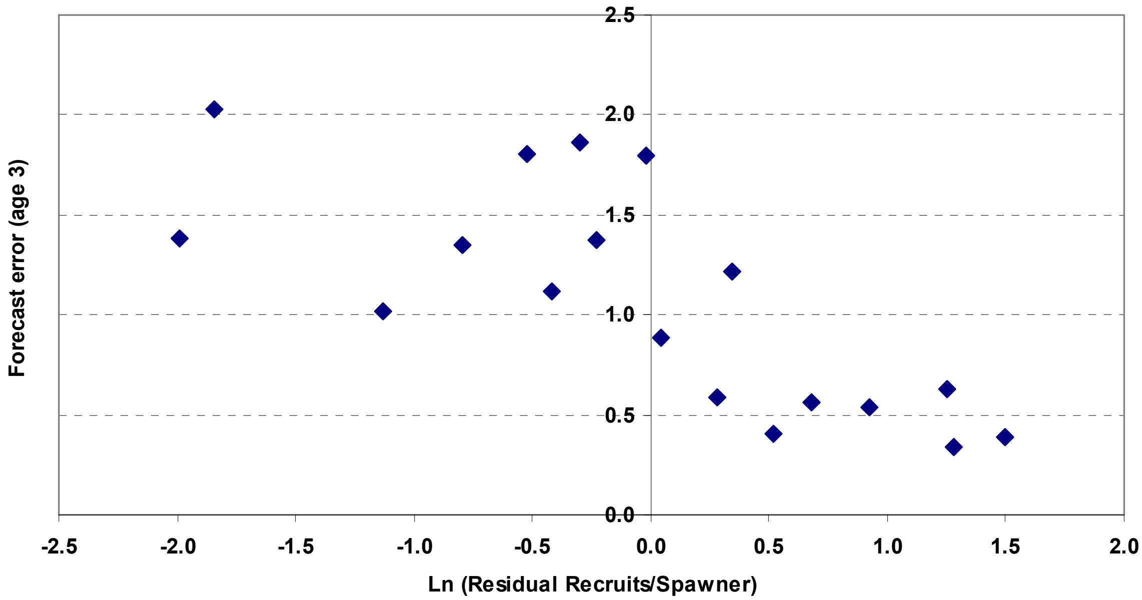


Figure G-3. Preseason forecast vs. postseason estimates of annual ocean abundance before fishing by age of Klamath fall Chinook, 1985-2005. Error = (forecast – actual) / actual

Table G-2. Regression results for correlations of forecast errors among ages.

	r	p
Age-3 vs. Age-4	-0.031	0.894
Age-4 vs. Age-5	0.006	0.981
Age-3 vs. Age-5	0.241	0.321



Regression Statistics	
Multiple R	0.58386156
R Square	0.340894321
Adjusted R Square	0.302123399
Standard Error	0.668247022
Observations	19

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regression	1	3.926338	3.926338	8.792525	0.008674
Residual	17	7.591419	0.446554		
Total	18	11.51776			

	Coefficients	*SE*	*t Stat*	*P-value*	*Lwr 95%*	*Upr 95%*
Intercept	1.074360619	0.153316	7.007483	2.11E-06	0.750891	1.39783
X Variable 1	-0.478838647	0.161485	-2.96522	0.008674	-0.81954	-0.13813

Figure G-4. Relationship between age-3 ocean abundance forecast error (preseason-postseason/postseason) and residuals of stock-recruitment equation fits for Klamath River fall Chinook, 1982-2000 brood years.

Fishery variance was reflected in differences between in-season target and post-season actual fishing rates (Figure G-5). For simulation purposes, target fishing rates were randomly varied to produce a pattern equivalent to that observed in comparisons of target and actual fishing rates in post season analyses. The fishery variance input was expressed as a coefficient of variation consistent with observed heteroscedasticity of the error variance (error variance in fishery impact rate is not constant over the range of rates but rather increases with increasing rate). Fishery variance was estimated from relative values of postseason versus preseason estimates of age-4 ocean harvest rate. This variance applied only to the ocean fishery. Variance of in river fishing rates was driven by forecast errors as previously described. All fisheries are constrained not to exceed an 80% contact rate of the available fish to avoid unrealistic extremes generated from a random distribution.

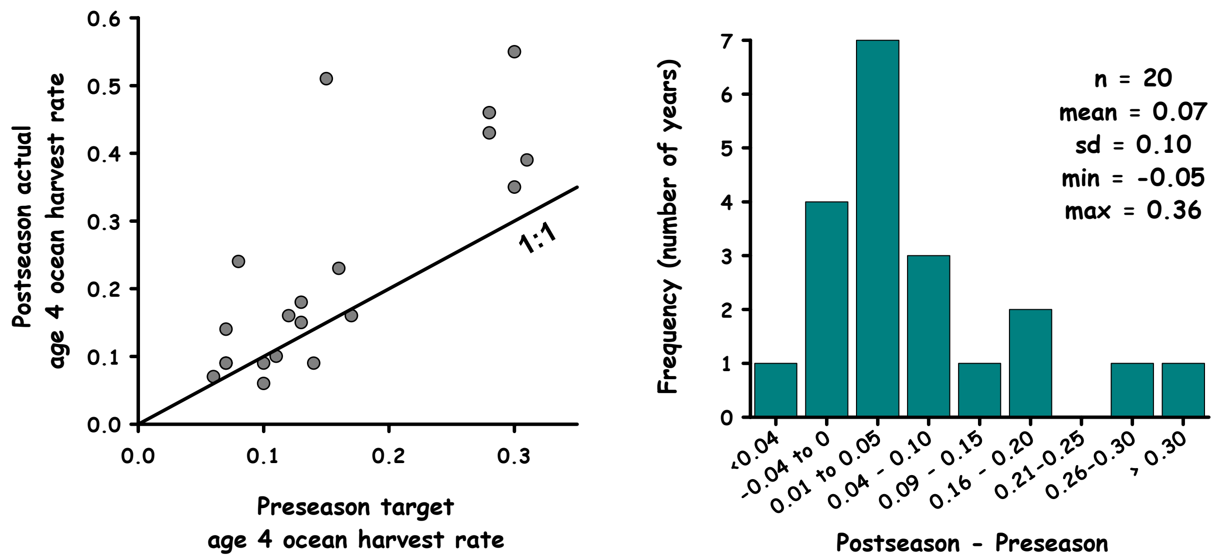


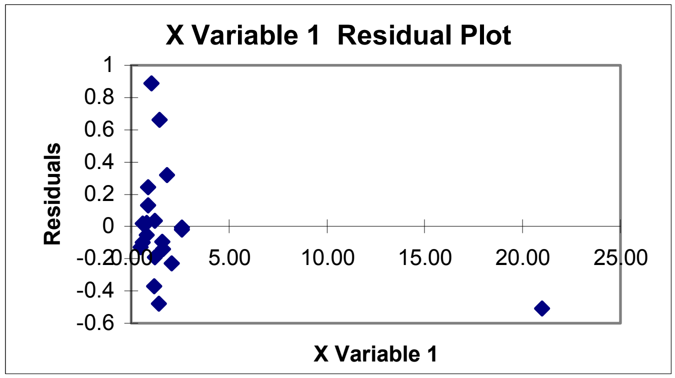
Figure G-5. Fishery variance based on preseason target and post-season actual estimates of age-4 ocean fishery harvest rates of Klamath fall Chinook for 1986-2006 (data from PFMC 2006).

Historical comparisons of post-season harvest rate estimates and preseason harvest rate forecasts also revealed a significant negative bias in forecast harvest rates by ocean fisheries. Actual rates averaged 30% greater than forecast rates for 1986-2006 (Figure G-5). The model included a bias parameter in ocean harvest rates to reflect this historical pattern. In actual practice, this consistent underestimation of ocean harvest rates has not been matched by the in-river tribal fishery due to the effort versus quota based management structure of the fisheries. As a result, tribal harvest shares have regularly fallen below the 50% target. This affect was captured in the current model formulation by basing in river harvests on preseason forecast numbers rather than actual fish numbers. For future modeling purposes, we assumed no bias in fishery implementation error based on a management intent to avoid this bias and changes in ocean models intended to correct the source of the bias.

Forecast and fishery variances were modeled independently because there was no significant correlation between forecast errors and preseason vs. post season differences in ocean age-4 harvest rates (Figure G-5). M. Mohr (personal communication) confirms that forecast errors in KRFC abundance and ocean harvest rates are not likely to be well-correlated. He notes that Chinook fisheries south of Falcon are time/area managed to achieve a KRFC harvest rate. A given time/area configuration is expected to result in a certain amount of distributed effort, and that level of effort is expected to result in a certain contact/harvest-rate, independent of KRFC abundance. Were these fisheries instead managed by KRFC quotas (as some are currently proposing to do with GSI data), then lower than expected KRFC abundance coupled with fixed KRFC quotas and sufficient effort would lead to higher KRFC harvest rates than predicted and vice-versa. However, to the extent that fishing effort varies from that expected under the time/area configuration, it is driven more by Central Valley abundance than by KRFC abundance, which aren't well-correlated. The realized level of effort therefore should largely be independent of KRFC abundance - predicted or actual.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.21161444
R Square	0.04478067
Adjusted R Square	-0.00828707
Standard Error	0.34802598
Observations	20



ANOVA

	df	SS	MS	F	Signif
Regression	1	0.10220763	0.102207633	0.84384	0.370447
Residual	18	2.18019754	0.121122086		
Total	19	2.28240518			

	Coefficients	SE	t Stat	P-value	Lwr 95%	Upr 95%
Intercept	0.681	0.176	3.873	0.001	0.312	1.051
X Variable 1	0.115	0.125	0.919	0.370	-0.148	0.377

Figure G-6. Results of regression of age-4 forecast error and the difference between target and actual age-4 ocean fishery harvest rate for Klamath fall Chinook, 1986-2005.

Initial Population Size.– Model runs are initiated with a starting population size (recent age-specific returns for partial cohorts rather than spawners). Near term numbers and risks are typically quite sensitive to this number while long term numbers and risks are not. The starting population size was based on forecast ocean numbers by age for 2006 and spawning recruits during the two previous years.

Stock-Recruitment Function.– Annual ocean recruitment of 3-year old fish (Sept. 1) is estimated in the model from spawner numbers using a Ricker stock-recruitment function (Figure G-7). Natural spawners include both naturally-produced fish and a portion of the hatchery-origin fish that do not return to the hatchery. Stock-recruitment function productivity and capacity parameters were derived from 1979-2000 brood year data based on a 2-stage survival formulation (model 2) as developed by the STT (2005). For modeling purposes, the function was refit to ocean age-4 recruits rather than spawner equivalent recruits as reported by the STT. Corresponding reference points were a stock size at sustainable equilibrium production (SEQ) of 112,300, a maximum sustainable production (SMSP) of 56,900, and maximum sustainable yield (SMSY) of 40,700. For Klamath fall Chinook, the Ricker stock-recruitment function accounts for about half of the density-independent model residual variation (STT 2005).

The SSRM incorporated variability about the stock-recruitment function to describe annual variation in fish numbers and productivity due to the effects of variable freshwater and marine survival patterns. The model assumed this variance to be lognormally distributed and highly autocorrelated. While stock-recruitment function parameters were derived using the 2-stage formulation, prospective simulations were based on the equivalent one-stage function, variance, and autocorrelation coefficients to avoid potential problems of covariance in error terms of the 2-stage model. Predicted future recruitment patterns were equivalent. The model also included limits on recruitment to prevent unrealistically large or small random numbers. Recruitment was limited to a maximum of 777,000 age-3 fish in the ocean corresponding to the maximum observed. Model escapements exceeding the maximum observed value of 162,000 were constrained to produce recruits equal to the model predicted-value for 162,000 spawners to avoid speculative inferences regarding the effects of larger escapements.

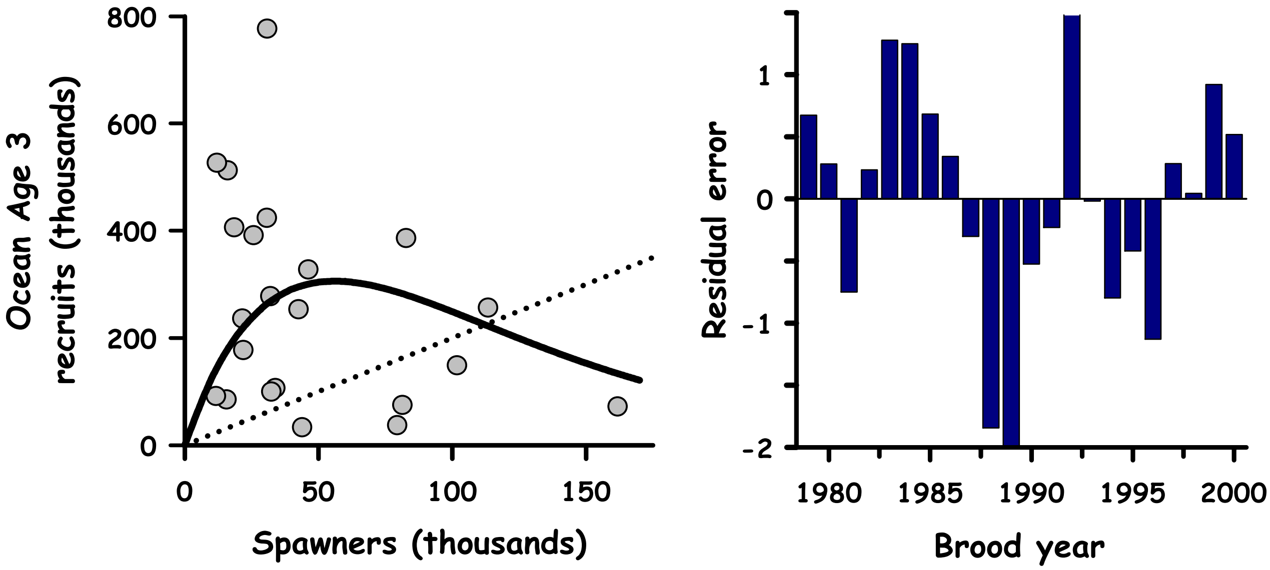


Figure G-7. Stock-recruitment relationship and annual pattern of residual error for 1979-2000 brood year data for Klamath fall chinook.

Depensation.– The model provided an option to limit recruitment at low spawner numbers consistent with depensatory effects of stock substructure and small population processes. Depensation was used to simulate population level effects of underfeeding of all spawning areas if significant substock structure exists for Klamath Fall Chinook. Because we lack data on substock structure and population dynamics at low escapements, model simulations assumed a depensatory response at escapements below 35,000 (corresponding to the management floor).

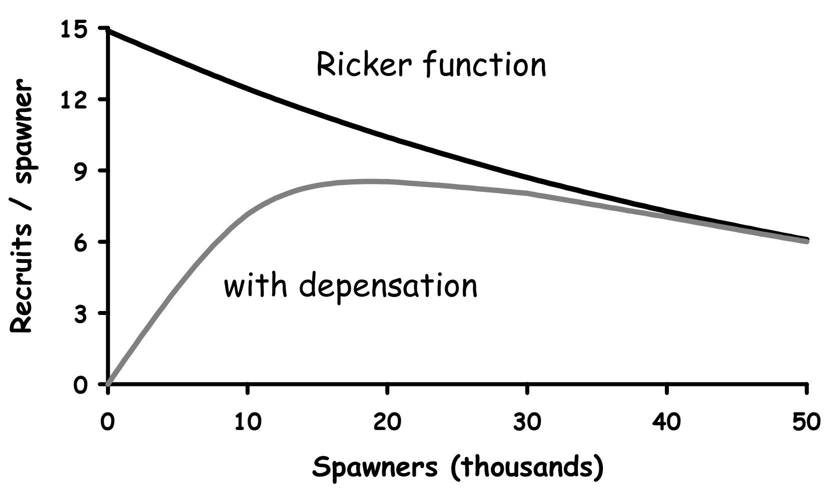


Figure G-8. Effect of depensation function on recruits per spawner at low spawner numbers.

Freshwater Production Trend.– An input parameter was included to allow the stock-recruitment productivity pattern to be annually incremented upward or downward so that effects of trends in habitat conditions might be considered. An annual decrement of 1% was used in sensitivity analysis of the effects of *de minimis* fishery alternatives under pessimistic conditions.

Maturation and Survival Rates.– Numbers of fish returning to the river or remaining in the ocean and surviving natural mortality were calculated by the model from ocean numbers using average annual natural mortality and maturation rates input as constant model parameters. Values were equivalent to those used in the Klamath Ocean Harvest Model (KOHM). The KOHM is a fishery management model that provides detailed estimates of catch by ocean fishery and month, fishery impact levels, and escapement for a given run size and fishing configuration in one year. Monthly natural survival rates used by KOHM were translated into an annual equivalent for use in the SSRM.

Hatchery production.– Hatchery and natural populations are modeled separately. Hatchery numbers recruiting to the age-3 population in the ocean are estimated from the current production goal for Klamath Fall Chinook and a juvenile to adult survival rate calibrated with the model to produce average hatchery escapements and hatchery:natural fractions comparable to those observed in the historical dataset. Release numbers and survival rates represent combined subyearling and yearling release numbers. Hatchery stray rates are an explicit model input and were a personal communication from LB Boydstun based on a review of the limited available data. Normal variation in hatchery survival rates among release cohorts was captured in the model using a scalar based on natural productivity derived from stock-recruitment function residual error. Thus, hatchery and natural numbers varied in strict tandem. The corresponding assumption would be that variation in hatchery and wild production was highly correlated due to common effects of freshwater and marine factors. This is obviously an oversimplification of hatchery stock dynamics but appears to represent numbers and variation on a scale consistent with the historical data. Future modifications of this analysis might consider a more explicit representation of natural and hatchery covariation.

Model Behavior

A series of simple simulations illustrates fish population and fishery dynamics as reflected in the simulation model. In a deterministic simulation with no fishing, ocean and spawner numbers rebound quickly from current low levels and oscillate around equilibrium values in a classical pattern driven by the Ricker stock-recruitment relationship. Equilibrium spawning escapement values of 114,000 are the product of stock-recruitment equation parameters (equilibrium production of 112,300) plus a small contribution of hatchery strays into natural spawning areas (5% of hatchery escapement).

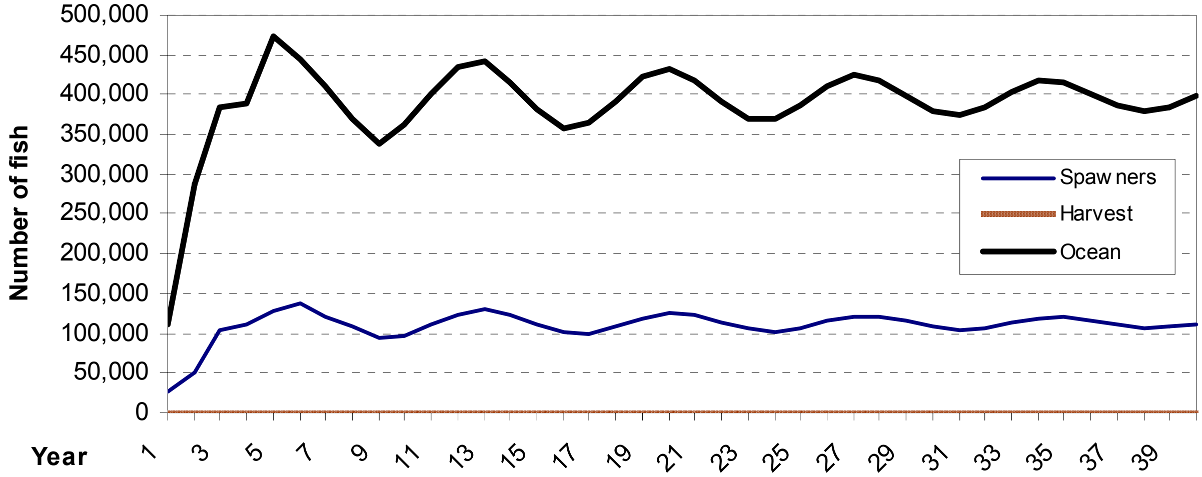


Figure G-9. Example results of a deterministic 40-year simulation in the absence of fishing and hatchery production.

Numbers rapidly reach a stable equilibrium in a deterministic simulation under a where the fishery which seeks to harvest all fish in excess of the spawner floor of 35,000 up to a maximum spawner reduction rate of 67% (FMP). In this case, the equilibrium spawner escapement is regulated by maximum spawner reduction rate rather than the spawner floor.

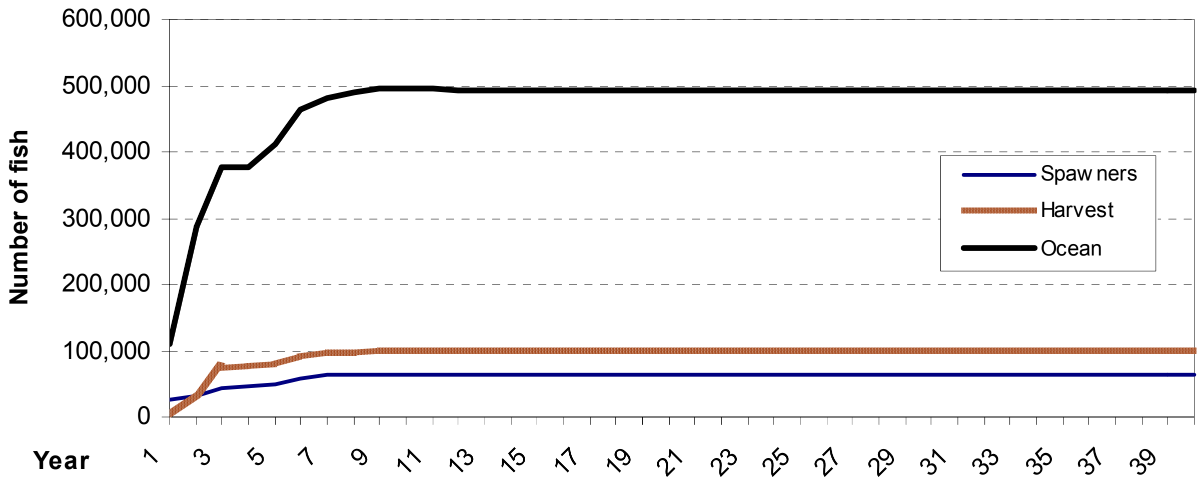


Figure G-10. Example results of a deterministic 40-year simulation with fisheries operating with a 35,000 escapement floor with a maximum 67% spawner reduction rate.

Patterns of annual fluctuation in fish numbers and harvest begin to resemble more typical real world patterns when normal random variation is introduced to the simulation.

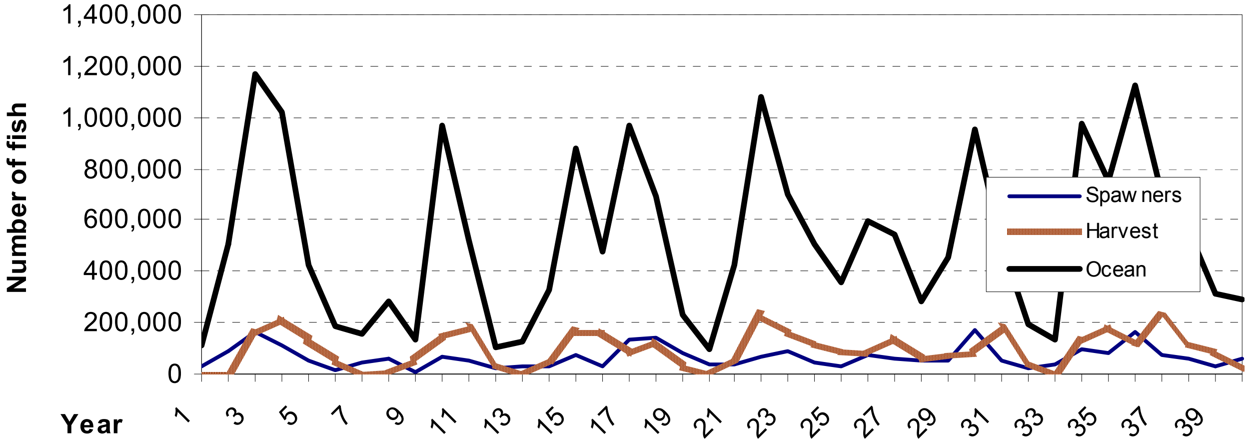


Figure G-11. Example results of a stochastic 40-year simulation under the current management plan with fisheries operating with a 35,000 escapement floor with a maximum 67% spawner reduction rate and random normal variation in recruits per spawner and fishing rates relative to annual targets.

Introduction of autocorrelation into the random recruitment function alters the pattern of variability. At the same net variance, the autocorrelation results is less local variation from year to year but larger high and low extremes as effects of sequences of better or poorer than average survival conditions are felt.

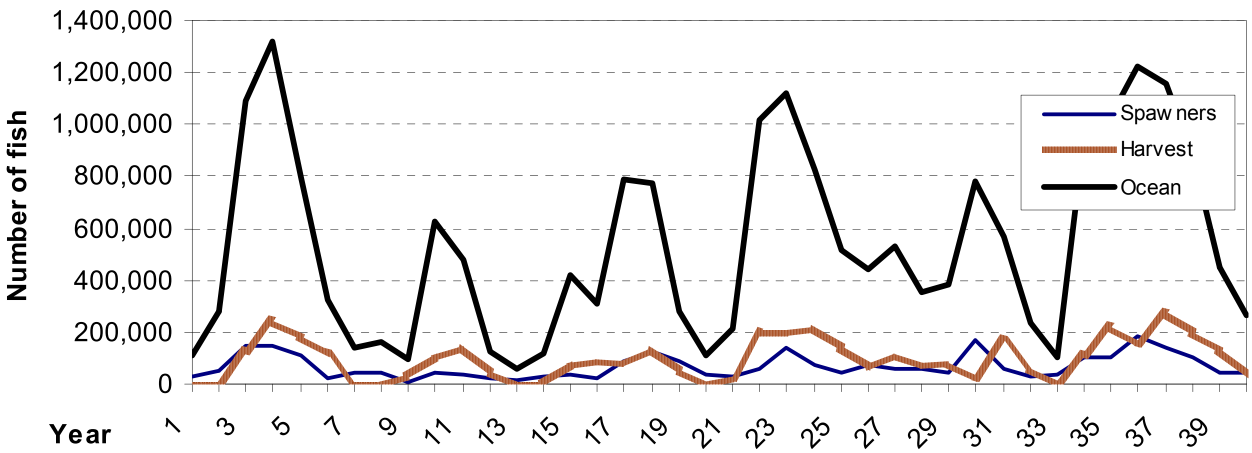


Figure G-12. Example results of a stochastic 40-year simulation under the historical fisheries management plan with fisheries operating with a 35,000 escapement floor with a maximum 67% spawner reduction rate and random normal variation in recruits per spawner and fishing rates relative to annual targets.

Model Calibration

A series of model calibration runs were made to test the model function and determine whether model inputs consistent with fishery patterns (see Table G-1) produced fishery and population dynamics like those observed in the historical dataset. Figure G-12 illustrates example model results for one iteration of a 40 year simulation of the calibration conditions. This example illustrates the normal variation in ocean population size, harvest in combined ocean and in river fisheries, and natural spawning escapement. Of course, annual patterns vary from iteration to iteration in a random fashion consistent with population and fishery variance inputs into the model.

Despite modest departures from the historical patterns in some model calibration results, the model produces very similar results for key variables of interest in evaluations of *de minimis* fishery alternatives. The current calibration of the model produces outputs of a scale that generally match historical averages and ranges of fish numbers and harvest in the ocean and the river. Modeled average ocean numbers and variation (509,000 and 68%) are very similar to historical averages (490,000 and 70%) (Table G-3). Frequency distributions of ocean numbers are closely comparable (Figure G-13). The model generally harvests fewer fish in the ocean than the historical average (61,600 vs. 80,000) and substantially more fish in the river than the historical average (57,000 vs. 30,000). Lower estimates of average ocean harvest by the model partly reflect the model parameterization that closes fisheries in years of low escapement. In contrast, at least some ocean harvest of Klamath fall Chinook occurred in all years from 1981-2005. Optimistic estimates by the model of the Klamath river runs relative to the 1981-2005 averages and maximums might also reflect poorer-than-average conditions represented in the recent historical record as well as changes in hatchery contributions over the last two decades. Modeled escapement numbers are similar to historical averages (Table G-3)and frequency distributions (Figure G-13). Model-predicted frequency of spawning escapements less than 35,000 (0.43) was less than the estimated frequency from 1981-2005 (0.56). Model-predicted tribal harvest shares averaged greater than observed values (42% vs. 32%) but reflected the historical pattern of less than 50% of the total.

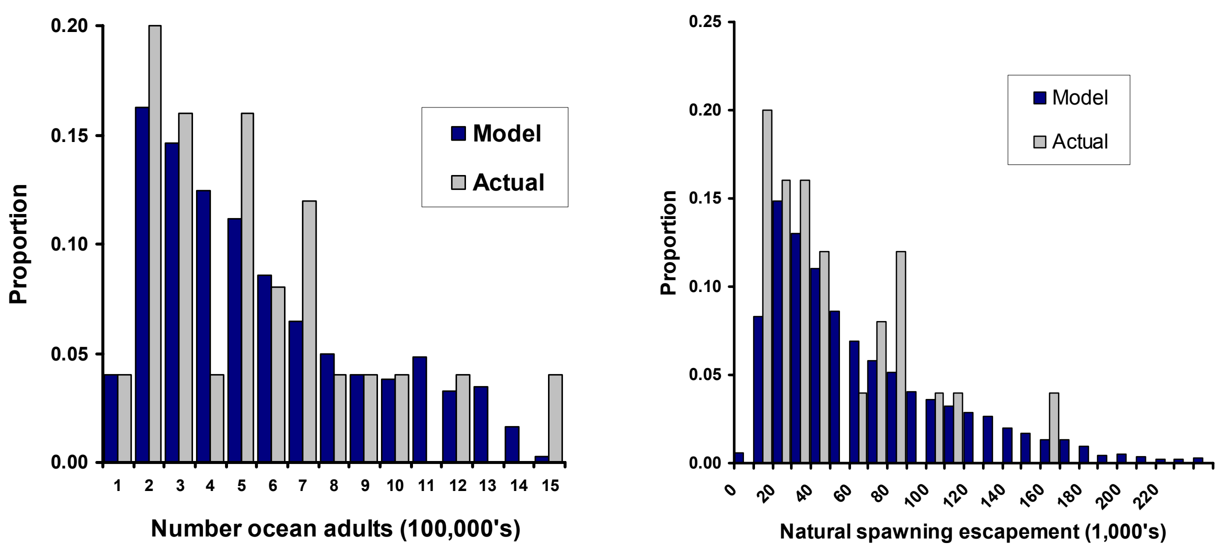


Figure G-13. Frequency distribution of ocean hatchery and natural adult abundance (left) and natural spawning escapement (right) of Klamath fall Chinook in 500 iterations of a 40 year simulation with the stochastic stock recruitment model relative to observed distribution estimated for 1981-2005.

Table G-3. Model results relative to actual historic numbers (based on fishery management according to the Fish Management Plan, historical bias in implemented ocean fishing rates, 35,000 escapement floor with a maximum 67% spawner reduction rate). Results are based on long term average results (model years 6-40) in 200 iterations of the model.

		Mean	CV	Minimum[a]	Max[a]
Ocean abundance [b]	1981-2005	490,000	70%	70,000	1,450,000
	Model	509,000	68%	15,600	1,500,000
Ocean harvest	1981-2005	80,000	130%	3,000	300,000
	Model	61,600	94%	0	325,000
Ocean harvest rate	1981-2005	27%	66%	6%	60%
(age-4)	Model	25%		0%	60%
River run	1981-2005	110,000	61%	27,000	223,000
	Model	129,000	61%	9,000	450,000
River harvest	1981-2005	30,000	70%	7,000	74,000
	Model	57,000	80%	0	300,000
Spawners (natural)	1981-2005	50,000	74%	12,000	160,000
	Model	55,000	75%	4,000	300,000
Spawners < 35,000	1981-2005	0.56	--	--	--
(frequency)	Model	0.43	--	--	--
Hatchery return	1981-2005	26,000	80%	4,400	98,000
	Model	25,000		1,000	300,000
Hatchery fraction	1981-2005	35%	32%	12%	54%
(in escapement	Model	32%			
Tribal harvest share	1981-2005	32%	58%	6%	68%
	Model	43%	--	10%	90%

[a] *minimum and maximum values are highly dependent on the number of model iterations.*
[b] *combined hatchery and wild fish, age-3 and 4 only.*

Results

Fishery Alternatives.– Status quo management is best represented by simulations of the FMP with a 16% ESA limit on ocean fishery harvest rates of age-4 fish (FMP/16). The model estimates a 28% frequency of escapements of less than 35,000 under this management strategy (Figure G-14, Table G-4). Improvements in the analytical basis of fishery management that eliminate consistently greater than target ocean harvest rates are projected to reduce the model frequency of low escapements by about 7% (FMP only past vs. present). The 16% limit on ocean harvest rates is projected to reduce the model frequency of low escapements by an absolute value of 10% relative to the fisheries management plan with only a 67% SRR cap (assuming an unbiased harvest rate implementation).

Analyses of fishery alternatives confirm that *de minimis* fishing rates of 13% or less have a limited effect on the incidence of spawning escapements of less than 35,000 (Figure G-14, Table G-4). *De minimis* rates of 5%, 10%, and 13% increase the absolute value of low run size risks by 1.5%, 3.7%, and 5.1%, respectively.

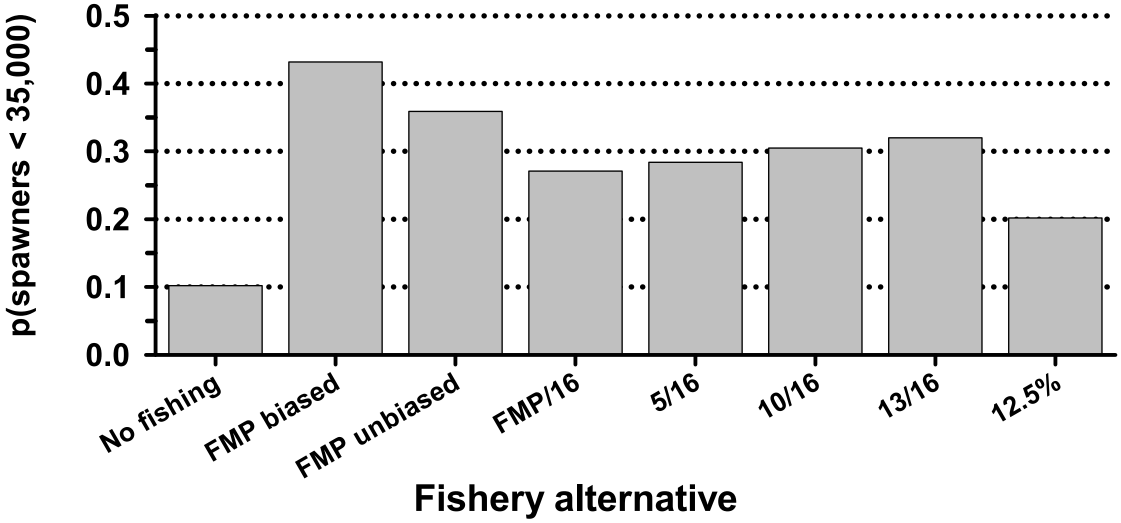


Figure G-14. Effects of fishing levels on the incidence of natural spawning escapements of less than 35,000. Format of labels is *de minimis* ocean fishery impact rate / maximum ocean fishery harvest rate (age-4 fish). FMP refers to Klamath fishery management plan.

All *de minimis* alternatives are projected by the model to produce a very low incidence (3% or less) of escapements below 12,000 which is the lowest observed in the historical dataset.

Frequencies of 2 or 3 consecutive years of escapements less than 35,000 (Overfishing Concern) are among the more sensitive indicators of *de minimis* fishery effects (Table G-4). The incidence of 3 year periods where escapement falls below 35,000 increases from 70% with no *de minimis* fisheries to 81.5% at a 13% *de minimis rate*.

De minimis fisheries would occur in 15% of years at rates of 5% or less and up to 24% of years at an impact rate of 13% (Table G-4). The increased frequency is primarily due to a greater number of years where the rate is applicable rather than a long term effect of fishing on fish numbers. The corresponding increase in Overfishing Concerns per 40 years is from 2.2 to 2.9 events on average over the 200 iterations.

Due to the effects of fishery forecast errors and normal variation on fishing rates, actual ocean fishery impacts are projected to exceed 17% (ESA consultation standard) from 39% to 44% of the time for *de minimis* fisheries of 0% to 13%. This metric is relatively insensitive to *de minimis* fishing rates of this scale with only a +4.8 increase.

Long-term average harvest and escapement of Klamath fall Chinook are little affected by the implementation of *de minimis* fisheries of 13% or less (Table G-4). The small numbers of fish affected during fishery implementation in low run years do not contribute significantly to total averages, however. harvest benefits of small fisheries in *de minimis* years are partially offset by loss of future production due to escapement effects.

Table G-4. Key results from Klamath stochastic stock recruitment model for *de minimis* fishing and other alternatives (200 iterations of 40 year time series).

	No	FMP only[2]		All with 16% ocean harvest rate limitation[3]				12.3% OIR for
Key Factors:	**fishing[1]**	**Biased**	**Unbiased**	**FMP[4]**	**5% *Demin*[5]**	**10% *Demin*[6]**	**13% *Demin*[7]**	**80%p>35K[8]**
yrs(E < 35,000)[9]	0.102	0.432	0.359	0.271	0.284	0.305	0.320	0.199
yrs(E < 21.000)[10]	0.021	0.191	0.138	0.081	0.093	0.125	0.148	0.093
yrs(E < 12,000)[11]	0.003	0.057	0.035	0.011	0.014	0.021	0.031	0.022
Iter (3yrs<35,000 in 40)[12]	0.280	0.930	0.865	0.700	0.740	0.785	0.815	0.615
freq (2yrs<35000 in 40)[13]	2.6	10.4	8.2	6.1	6.6	7.5	8.2	5.0
freq (3yrs<35000 in 40)[14]	0.8	6.2	4.7	3.2	3.6	4.4	5.0	2.5
yrs(de min fishery)[15]	0.000	0.000	0.000	0.000	0.148	0.199	0.237	0.000
yrs(ocn 4 IR > 0.17)[16]	0.000	0.672	0.553	0.389	0.388	0.400	0.437	0.223
yrs(ocn 4 IR <= 0.05)[17]	1.000	0.176	0.210	0.221	0.155	0.098	0.087	0.119
yrs(egg take goal)[18]	0.866	0.645	0.666	0.705	0.702	0.698	0.689	0.796
yrs(0%<rt<50%)[19]	0.000	0.727	0.562	0.463	0.492	0.495	0.499	0.495
freq(Overfishing event)[20]	1.3	3.5	2.9	2.2	2.4	2.6	2.9	1.9
Ocean Harvest[21]	0	59,000	48,000	32,800	33,100	33,300	33,500	24,800
River Harvest[22]	0	55,000	59,000	60,900	60,900	60,700	60,300	34,100
Natural Escapement[23]	137,000	53,000	61,000	72,400	71,500	69,800	68,400	94,100

[1] Included to illustrate normal population dynamics in the absence of fishing.
[2] Fishery management plan with no fishing below 35,000 floor and the spawner reduction rate not to exceed 67%. Biased and Unbiased refer to fishery implementation practices which historically often resulted in a greater-than-target harvest rates but currently are presumed to produce target harvest rates on average.
[3] Ocean harvest rate (landed catch only) limitation based on California coastal chinook ESA standard (~17% ocean fishery impact rate).
[4] Fishery management plan with 16% (~17% ocean fishery impact rate including nonlanded mortality). Status quo management equivalent to a 0% de minimis rate.
[5] 5% de minimis ocean fishery impact rate on age-4 fish and a maximum harvest rate of 16% (~17% ocean fishery impact rate).
[6] 10% de minimis ocean fishery impact rate on age-4 fish and a maximum harvest rate of 16% (~17% ocean fishery impact rate).
[7] 13% de minimis ocean fishery impact rate on age-4 fish and a maximum harvest rate of 16% (~17% ocean fishery impact rate).
[8] Fixed annual ocean fishery impact rate (12.3%) that produces an 80% probability of spawning escapements greater than 35,000.
[9] Annual frequency of escapements of less than 35,000 natural spawners (n= 200 iterations x 40 years).
[10] Annual frequency of escapements of less than 21,000 natural spawners (n= 200 iterations x 40 years). 21,000 is an arbitrary reference point representing a more conservative risk level than the spawner floor.
[11] Annual frequency of escapements of less than 12,000 natural spawners (n= 200 iterations x 40 years). 12,000 is an reference point representing the lowest number of spawners historically observed.
[12] Proportion of 40-year iterations in which spawning escapement falls below 35,000 in three consecutive years (n= 200 iterations).
[13] Average number of years in 200 iterations where spawning escapement falls below 35,000 in 2 consecutive years.
[14] Average number of years in 200 iterations where spawning escapement falls below 35,000 in 3 consecutive years.
[15] Annual frequency of de minimis fishery implementation (n= 200 iterations x 40 years).
[16] Annual frequency of years in which ocean fishery impact rates on age-4 fish exceed 17% (n= 200 iterations x 40 years).
[17] Annual frequency of years in which ocean fishery impact rates on age-4 fish are 5% or less (n= 200 iterations x 40 years).
[18] Annual frequency of hatchery escapements that provide the egg take needed to meet hatchery production goals (n= 200 iterations x 40 years).
[19] Annual frequency of years in which tribal harvest share falls below 50% (n= years where fisheries occur).
[20] Average number of overfishing events that occur within the 40 year period in 200 iterations.
[21] Average annual ocean harvest in combined troll and recreational fisheries (n= 200 iterations x 40 years).
[22] Average annual river harvest in combined net and recreational fisheries (n= 200 iterations x 40 years).
[23] Average annual spawning natural escapement of natural and hatchery produced fish (n= 200 iterations x 40 years).

Near-term vs. long term risks.– The model tracks results separately in years 1 to 5 and years 6-40 in order to assess near term and long term risks. Because of recent low numbers of spawners, near term risks of low escapements are greater than long term risks, and near term harvest and escapement levels are less than long term expectations.

Table G-5. Key short-term (1-5 year) and long-term (6-40 year) results for *de minimis* fishing alternatives. [a]

Key Factors:	Status Quo[b/]	5% Cap[c/]	10% Cap[d/]	13% Cap[e/]
Years Spawning Escapement < 35,000f/	**0.271**	**0.284**	**0.305**	**0.320**
Years 1-5	0.461	0.485	0.518	0.534
Years 6-40	0.244	0.255	0.274	0.289
Years Spawning Escapement <21,000g/				
Years 1-5				
Years 6-40				
Years Spawning Escapement <12,000h/	**0.011**	**0.014**	**0.021**	**0.031**
Years 1-5	0.019	0.023	0.029	0.064
Years 6-40	0.009	0.013	0.019	0.026
Years Age-4 Ocean Harvest Rate ≥ 0.16i/	**0.389**	**0.388**	**0.400**	**0.437**
Years 1-5	0.264	0.260	0.284	0.356
Years 6-40	0.407	0.406	0.416	0.448
Average Annual Ocean Harvest (Troll & Sport)	**32832**	**33061**	**33305**	**33469**
Years 1-5	21086	21672	22291	22730
Years 6-40	34510	34689	34878	35003
De minimis years only	--	3672	7950	11028
Average Annual Tribal Harvest	**48834**	**48798**	**48589**	**48313**
Years 1-5	33010	33219	33321	33295
Years 6-40	51095	51023	50770	50458
De minimis years only	--	2764	6277	8584
Average Annual River Recreational Harvest	**12071**	**12081**	**12063**	**12036**
Years 1-5	8331	8376	8366	8330
Years 6-40	12605	12610	12591	12565
De minimis years only	--	706	1551	2158
Average Annual Natural Spawning Escapement	**72444**	**71470**	**69845**	**68423**
Years 1-5	58002	55897	52916	50408
Years 6-40	74507	73694	72263	70996
De minimis years only	--	40627	38691	37996

a/ All Alternatives include the CCC ESA consultation standard limitation of ≤16.0% age-4 ocean harvest rate (landed catch only; ≈17% age-4 ocean impact rate).
b/ No fishing when projected natural spawning escapement <35,000.
c/ *De minimis* fishing limited to no more than a 5% age-4 ocean impact rate with a threshold of unfished natural spawning escapement of less than about 40,000.
d/ *De minimis* fishing limited to no more than a 10% age-4 ocean impact rate with a threshold of unfished natural spawning escapement of less than about 47,000.
e/ *De minimis* fishing limited to no more than a 13% age-4 ocean impact rate with a threshold of unfished natural spawning escapement of less than about 52,000.
f/ Probability of an escapement less than the 35,000 natural spawner floor (KRFC conservation objective) in any one year.
g/ Probability of an escapement less than 21,000 natural spawners in any one year.
h/ Probability of an escapement less than 12,000 natural spawners (lowest on record) in any one year.
i/ Probability of not meeting the ESA consultation standard for California Coastal Chinook ESU age-4 coean harvest rate ≤ 16.0%) in any one year.

Sensitivity analysis.– Sensitivity analyses were used to examine the influence of key model inputs on the effects of *de minimis* fishing rates. These involved a series of simulations where input parameters were changed one at a time for each of 0%, 5%, 10% and 15% *de minimis* rates (all with 16% ocean harvest rate limitation). Results are depicted in Figure G-15 and Figure G-16. Sensitivity analyses show a consistent pattern in the relative effects of de minimis fishing rate on the likelihood of escapements less than 35,000 for a wide range of parameter inputs. Increasing *de minimis* rates marginally increase low run size risks but the slope of the effect is quite similar for different model input parameters. This is not a particularly surprising conclusion because each fisheries under each *de minimis* strategy are similarly affected by input parameter changes. This robust performance of the model, where used in a relative fashion provides confidence in conclusions regarding the relative effect of one *de minimis* alternative relative to another.

While relative effects of fishery alternatives were consistent among different input parameters, absolute values of low run size risks where often sensitive to parameter values. For instance, low run size risks were quite sensitive to assumptions regarding the inherent productivity of the Klamath Fall Chinook population (Figure G-15). The available stock recruitment data indicated that the Ricker stock-recruitment productivity parameter (α) was approximately 15.0 age-3 recruits per spawner at low spawner densities. This parameter resulted in low run size risks of approximately 27-32% at *de minimis* fishing rates of 0-15%. Low run size risks increased approximately 5% per every 2 recruit per spawner reduction in the productivity parameter. Absolute values of low run size risk were similarly sensitive to freshwater production trend and depensation parameters which affect productivity (Figure G-15).
Absolute values of low run size risks were also moderately sensitive to recruitment variation, recruitment autocorrelation, fishery implementation bias (which affects actual vs. target fishing rates, and fishery implementation variance. Absolute values of low run size risks were relatively insensitive to forecast errors (Figure G-16) which affected in-river harvests and harvest shares but were independent of fishery implementation variance according to the historic dataset. Absolute values of low run size risks were hatchery stray rates of 0-20% because these contributed low numbers of natural spawners relative to the natural population size.

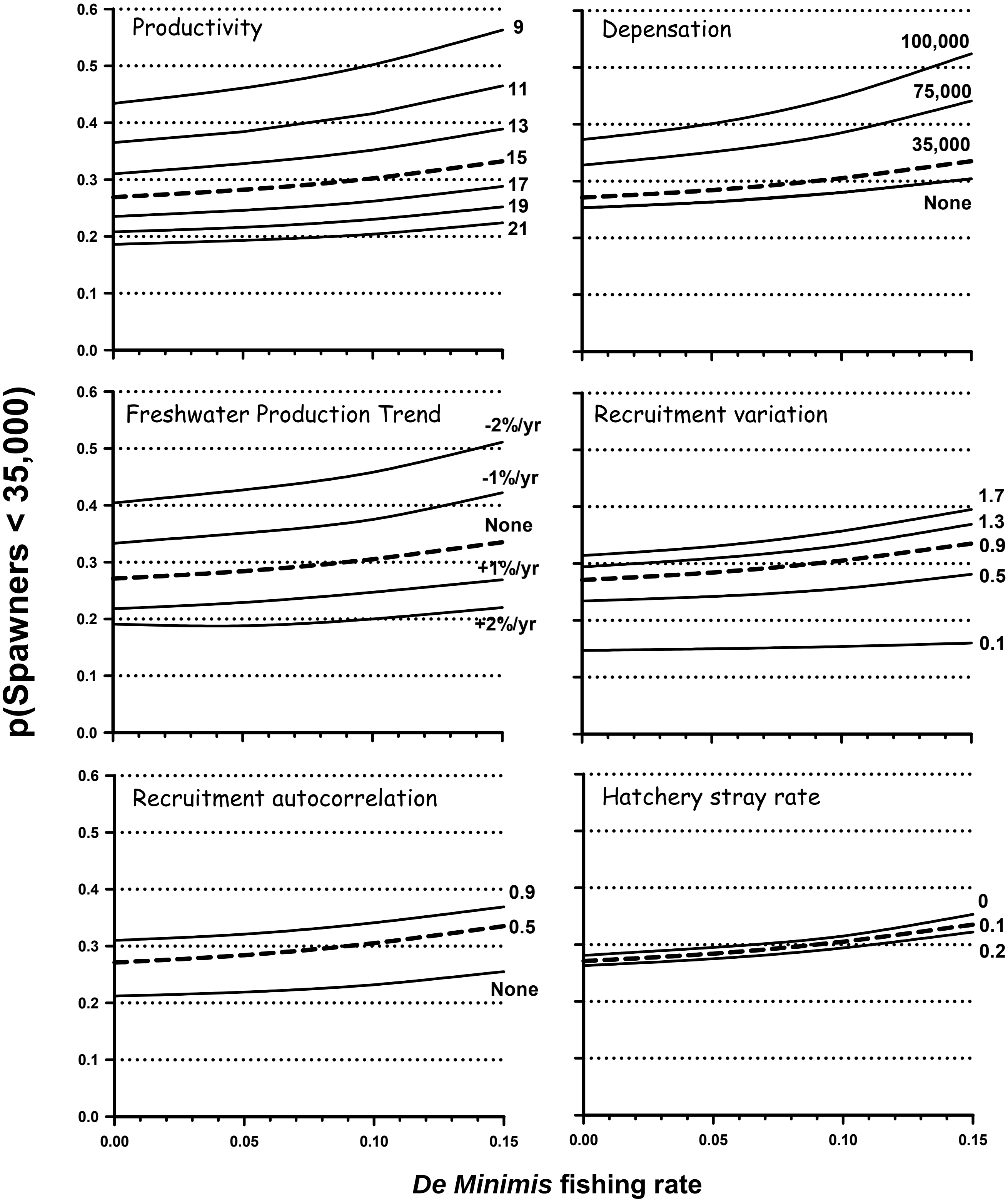


Figure G-15. Sensitivity of the frequency of natural spawning escapements of less than 35,000 to De minimis fishing rates and input parameters. Estimated values for each parameter are depicted with a dashed line.

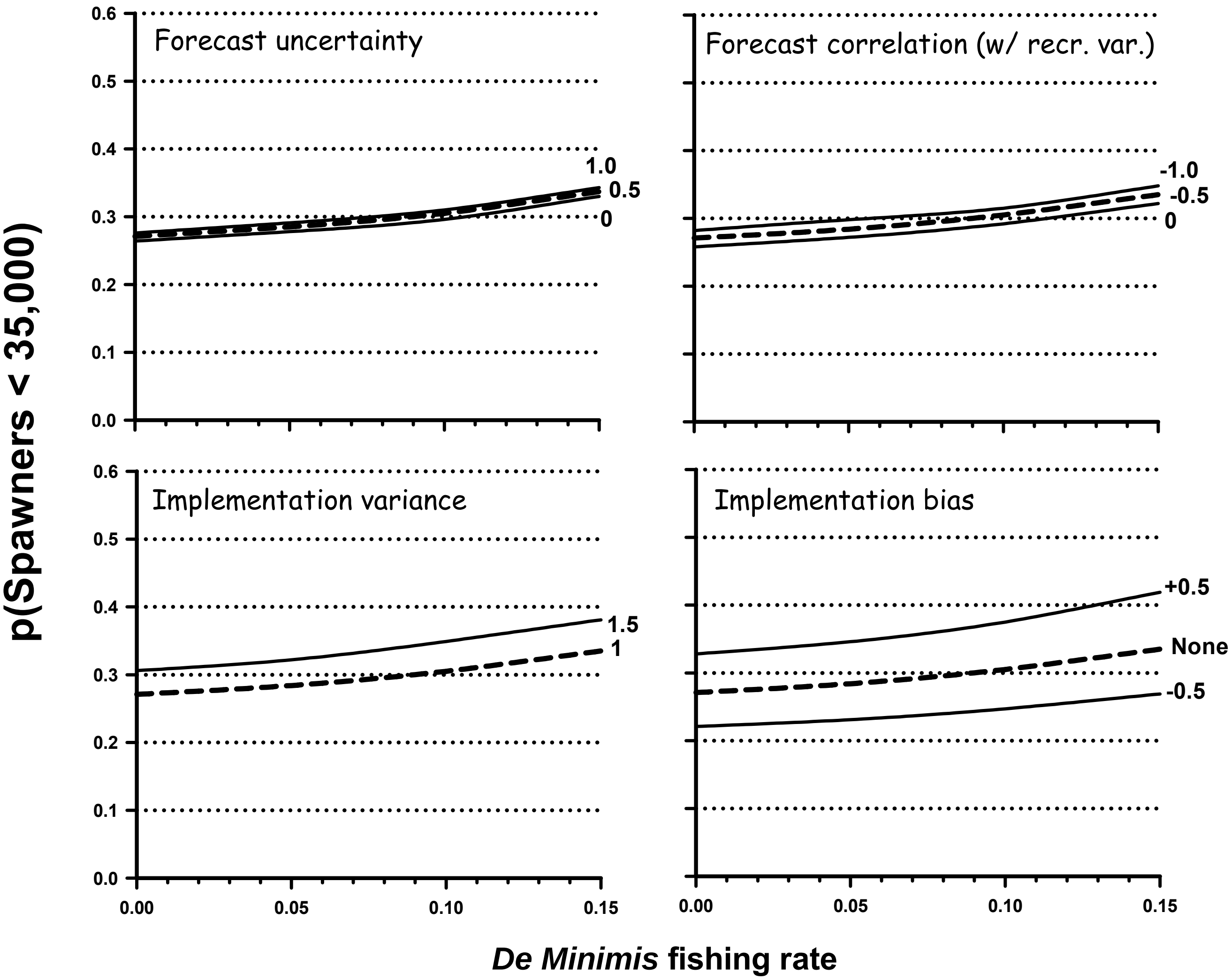


Figure G-16. Sensitivity of the frequency of natural spawning escapements of less than 35,000 to De minimis fishing rates and input parameters. Estimated values for each parameter are depicted with a dashed line.

Discussion

The modeling confirms that at low fishing rates, future long-term effects on escapement and harvest are lost in the normal real world variability in the system. Conclusions are the same as those previously reported by Prager and Mohr (2001) using a similar modeling approach.

Comparisons of the relative effects of alternative fishing strategies on population and fishery performance are a relatively robust application of the modeling tool. Sensitivity analyses to different combinations of input parameters confirm that the relative effects of *de minimis* fishing rates are consistent among different parameterizations of the model. (Relative changes in escapement and harvest due to changes in de minimis fishing rates are similar for different combinations of population and fishery parameters.)

The modeling necessarily relies on some simplifying assumptions that warrant additional evaluation in order to qualify results. One assumption of particular concern is the effects of substock structure within the aggregate Klamath fall Chinook return. An aggregate stock-recruitment relationship may not adequately reflect the conservation risks associated low spawning escapements where substock structure exists (due to potential underfeeding of some areas and possible low population genetic or demographic risks). Corresponding risks were examined in this analysis with population simulations examining the sensitivity of results to alternative assumptions using the least productive substock, a depensatory stock-recruitment relationship at low spawner numbers.
Model analyses were focused on Klamath fall Chinook. Fishery effects will be highly dependent on the productivity of the subject stock –highly productive stocks tend to be much less sensitive to fishing at low escapements than less productive stocks that are less likely to bounce back quickly and seem to be more prone to large swings in survival. Thus, fishing strategies appropriate for Klamath fall Chinook may not be specifically transferable to other stocks of interest. Sensitivity analyses of the effects of fishing strategies and rates at a range of inherent stock productivities to would provide a basis for consideration of other applications as appropriate.

These results will inform policy decisions on appropriate fishing strategies. Acceptable levels of effect and risk will remain a policy decision. Thus, the modeling answers the effect questions (what are the effects of the fishery alternatives?) but still requires policy answers to the corresponding goal question (what effects are acceptable?); e.g., is a 3% increase in the frequency of escapements of less than 35,000 an acceptable risk in exchange for increased management flexibility in low run years? One approach to considering how much risk is too much would be to ask how many years of data would be required to detect a difference caused by implementation of an alternative fishery strategy. Future analyses could include this evaluation.

This biological analysis evaluates the effects of fishing on the Klamath Fall Chinook population and fishery but does not directly consider the effects of Klamath fall Chinook harvest constraints on the much larger catches of other California and Oregon Chinook stocks in ocean fisheries. Companion economic analyses will paint a much more complete picture of the broader effects of Klamath fishing levels.

References

KRTAC (Klamath River Technical Advisory Team). 1999. Population dynamics of Klamath River Fall Chinook Salmon: Stock-recruitment model and simulation of yield under management. Pacific Fishery Management Council.

KRFCRT (Klamath River Fall Chinook Review Team). 1994. An assessment of the status of the Klamath River fall Chinook stock as required under the salmon fishery management plan. Pacific Fishery Management Council.

KRTT (Klamath River Technical Team). 1986. Recommended spawning escapement policy for Klamath River fall-run Chinook. Technical Report to the Klamath Fishery Management Council. 73 p.

PFMC (Pacific Fishery Management Council). 2005. Salmon Technical Team report on the technical basis for the Klamath River fall Chinook conservation objective. Agenda Item D.1.b

PFMC (Pacific Fishery Management Council). 2006a. Review of 2005 ocean salmon fisheries.

PFMC (Pacific Fishery Management Council). 2006b. Preseason Report I: stock abundance analysis for 2006 ocean salmon fisheries.

PFMC (Pacific Fishery Management Council). 2006c. FMP amendment scoping for de minimis fisheries associated with Klamath River fall Chinook impacts. Agenda Item C.7.

Prager, M. H. and M. S. Mohr. 1999. The harvest rate model for Klamath River fall Chinook salmon: Model definition, solution, and implementation. NMFS Administrative Report T-2000-01. Tiburon, CA.

Prager, M. H. and M. S. Mohr. 2001. The harvest rate model for Klamath River fall Chinook salmon, with management applications and comments on model development and documentation. North American Journal of Fisheries Management 21:533-547.

STT (Salmon Technical Team). 2005. Klamath River fall Chinook stock-recruitment analysis. Pacific Fishery Management Council.

Sub-Appendix a – Annual Klamath Data

Sub Appendix Table G(a)-1. Klamath fall Chinook data (PFMC 2006a, 2006b). Numbers are in thousands.

	Ocean abundance (H & W)			Ocean harvest			River run			Maturation rate		In river harvest			Tribal	Spawners (adults)			Hat.
Year	age-3	age-4	3 + 4	age-3	age-4	3 + 4	age-3	age-4	Total	age-3	age-4	Net	Sport	Total	share	Hat.	Nat.	Total	Prop.
1981	493.2	57.0	550.2	103.6	30.2	133.8	64.1	14.4	80.3	0.16	0.54	33.0	6.0	39.0	0.19	4.4	33.9	38.3	0.12
1982	566.4	133.4	699.8	169.9	69.4	239.3	30.1	33.9	66.6	0.08	0.53	14.5	8.3	22.8	0.06	10.4	32.0	42.4	0.25
1983	317.2	116.4	433.6	60.3	69.8	130.1	35.9	20.7	57.5	0.14	0.44	7.9	4.2	12.1	0.06	13.9	30.8	44.6	0.31
1984	157.1	83.7	240.8	12.6	31.8	44.4	21.7	24.4	47.3	0.15	0.47	18.7	3.3	22.0	0.28	7.5	16.1	23.6	0.32
1985	375.3	56.7	432.0	41.3	13.6	54.9	32.9	25.7	64.4	0.10	0.60	11.6	3.6	15.1	0.17	22.5	25.7	48.2	0.47
1986	1308.7	141.2	1449.9	238.0	64.3	302.3	162.9	29.8	195.0	0.15	0.39	25.1	21.0	46.2	0.07	32.9	113.4	146.3	0.22
1987	783.0	343.6	1126.6	121.7	146.5	268.2	89.7	112.6	209.1	0.14	0.57	53.1	20.2	73.3	0.16	29.1	101.7	130.8	0.22
1988	758.6	236.2	994.8	153.8	92.9	246.8	101.2	86.5	191.6	0.17	0.60	51.7	22.2	73.9	0.16	33.5	79.4	112.9	0.30
1989	368.0	178.1	546.1	57.0	65.0	122.0	50.4	69.6	124.3	0.16	0.62	45.6	8.8	54.3	0.26	22.0	43.9	65.9	0.33
1990	176.8	103.3	280.1	52.2	56.8	109.1	11.6	22.9	35.9	0.09	0.49	7.9	3.6	11.5	0.07	8.1	15.6	23.7	0.34
1991	69.6	37.3	106.9	2.2	6.7	8.9	10.0	21.6	32.7	0.15	0.71	10.2	3.4	13.6	0.45	6.5	11.6	18.1	0.36
1992	39.6	28.3	67.9	1.0	2.0	3.0	6.9	18.8	26.7	0.18	0.72	5.8	1.0	6.8	0.59	7.4	12.0	19.4	0.38
1993	168.9	15.1	184.0	8.1	2.5	10.6	48.3	8.2	57.2	0.30	0.65	9.6	3.2	12.8	0.41	21.6	21.9	43.5	0.50
1994	120.3	41.8	162.1	4.0	3.8	7.8	37.0	26.0	64.0	0.32	0.68	11.7	1.8	13.5	0.55	17.1	32.3	49.4	0.35
1995	784.2	28.8	813.0	28.0	3.9	31.9	201.9	18.3	222.8	0.27	0.74	15.6	6.1	21.6	0.29	37.9	161.8	199.7	0.19
1996	191.0	225.9	416.9	9.2	35.4	44.6	38.8	136.7	175.8	0.21	0.72	56.5	12.8	69.2	0.50	20.0	81.3	101.4	0.20
1997	140.8	63.0	203.8	2.1	3.6	5.7	35.0	44.2	83.7	0.25	0.74	12.1	5.7	17.8	0.51	18.7	46.1	64.8	0.29
1998	154.7	45.0	199.7	0.8	4.2	5.0	59.2	29.7	90.6	0.38	0.73	10.2	7.7	17.9	0.45	29.2	42.5	71.7	0.41
1999	129.7	30.3	160.0	1.9	2.7	4.7	29.2	20.5	51.0	0.23	0.74	14.7	2.3	16.9	0.68	14.3	18.5	32.8	0.44
2000	618.7	44.5	663.2	37.7	4.6	42.3	187.1	30.5	218.1	0.32	0.76	29.4	5.7	35.1	0.38	97.6	82.7	180.3	0.54
2001	358.2	134.2	492.4	9.1	12.7	21.8	99.1	88.2	187.3	0.28	0.73	38.6	12.1	50.8	0.53	55.1	77.8	132.9	0.41
2002	565.7	100.0	665.7	14.7	15.5	30.2	94.6	62.5	160.8	0.17	0.74	24.6	10.5	35.1	0.38	27.2	65.6	92.8	0.29
2003	540.7	220.2	760.9	50.3	50.1	100.4	94.3	96.8	191.9	0.19	0.57	30.0	9.7	39.7	0.21	61.8	87.6	149.4	0.41
2004	159.2	166.5	325.7	21.2	84.6	105.8	33.2	40.7	78.9	0.24	0.50	25.8	4.0	29.8	0.19	23.0	24.1	47.1	0.49
2005	209.5	34.8	244.3	4.9	8.3	13.2	43.9	17.5	65.3	0.21	0.66	8.0	1.6	9.6	0.35	27.7	27.3	55.0	0.50
avg	382	107	489	48.2	35.2	83.5	64.8	44.0	111.2	0.20	0.63	22.9	7.5	30.4	0.32	26.0	51.4	77.4	0.35
sd	303	83	346	62.5	37.6	91.7	53.2	34.6	67.8	0.08	0.11	15.7	6.1	20.6	0.18	20.5	38.0	52.6	0.11
cv	0.79	0.78	0.71	1.30	1.07	1.10	0.82	0.79	0.61	0.39	0.18	0.68	0.80	0.68	0.58	0.79	0.74	0.68	0.32
min	40	15	68	0.8	2.0	3.0	6.9	8.2	26.7	0.08	0.39	5.8	1.0	6.8	0.06	4.4	11.6	18.1	0.12
max	1,309	344	1,450	238.0	146.5	302.3	201.9	136.7	222.8	0.38	0.76	56.5	22.2	73.9	0.68	97.6	161.8	199.7	0.54

Natural spawners include hatchery strays. Hatchery spawners are rack return.

Sub-Appendix b –Model Details

The complete model formula is contained in the source code included in a subsequent appendix. This section describes the derivation of key portions of the model.

Fishery Contact Rate

The model calculates fishery contact rates in ocean troll, ocean sport, river net, and river sport based on target ocean impact rates as follows (as adapted from Prager and Mohr 2001).

$$F_{a,i} = I_{a,i} / N_a \qquad (1)$$

where

- a = age (3, 4, 5)
- i = fishery (ot = ocean troll, or = ocean recreational, rt = river tribal, rr = river recreational)
- $F_{a,i}$ = fishery impact (proportion of number that die as a result of direct or indirect fishery effects
- $I_{a,i}$ = number of fish impacted by the fishery (total mortalities) by age and fishery
- N_a = actual number of fish in population by age

$$I_{a,i} = H_{a,i} + S_{a,i} + D_{a,i} \qquad (2)$$

where

- $H_{a,i}$ = harvest mortality (number of deaths)
- $S_{a,i}$ =“shaker” or catch and release mortality (number of deaths)
- $D_{a,i}$ = drop off mortality (number of deaths)

The number contacted at age is defined as the product of abundance at age (N_a), age-4 contact rate (c_i), and age-specific vulnerability (v_a):

$$C_{a,i} = N_a \, c_i \, v_{a,i} \qquad (3)$$

Thus,

$$H_{a,i} = C_{a,i} \; l_{a,i} \qquad (4)$$

$$S_{a,i} = C_{a,i} \; (1- l_{a,i}) \, s_{a,i} \qquad (5)$$

$$D_{a,i} = C_{a,i} \; d_i \qquad (6)$$

where

- $l_{a,i}$ = age-specific and fishery-specific portion of fish of legal size.
- $s_{a,i}$ = “shaker” or catch and release mortality rate.
- d_i = drop off mortality rate which is computed as a specified multiple of the number of fish contacted.

In the case of two concurrent ocean fisheries:

$$F_{4.} = (I_{4,ot} + I_{4,or}) / N_4 \qquad (7)$$

or

$$F_{4.} = \{[N_4 \, c_{ot} \, v_{4,ot} \, l_{4,ot} + N_4 c_{ot} v_{4,ot} \, (1-l_{4,ot}) s_{4,ot} + N_4 c_4 \, v_{4,ot} \, d_{4,ot}] + [N_4 c_{ot} \, v_{4,ot} \, l_{4,ot} + N_4 c_{ot} v_{4,ot} \, (1-l_{4,ot}) s_{4,ot} + N_4 c_4 \, v_{4,ot} \, d_{4,ot}]\} / N_4 \qquad (8)$$

or

$$F_{4.} = c_{ot} \, v_{4,ot} \, [l_{4,ot} + (1-l_{4,ot}) s_{4,ot} + d_{4,ot}] + c_{or} \, v_{4,ot} \, [l_{4,or} + (1-l_{4,or}) s_{4,or} + d_{4,or}] \qquad (9)$$

Model inputs harvest allocations for each fishery

- A_{ot} = proportion of the annual harvest allocated to the ocean troll fishery
- A_{or} = proportion of the annual harvest allocated to the ocean recreational fishery
- A_{rt} = proportion of the annual harvest allocated to the river tribal fishery
- A_{rr} = proportion of the annual harvest allocated to the river recreational fishery

Thus,

$$H_{4,or} = H_{4,ot} \; (A_{or} / A_{ot}) \qquad (10)$$

Substituting eqns (3) and (4) into (10), we can define the ocean recreational fishery contact rate in terms of the ocean troll fishery contact rate:

$$c_{4,or} = c_{ot} [(A_{or} v_{4,ot} l_{4,ot}) / (A_{ot} v_{4,or} l_{4,or})] \quad (11)$$

Substituting eqn (11) into (9) allows us to define the ocean sport fishery contact rate:

$$c_{4,ot} = F_{4.} / \{ v_{4,ot} [l_{4,ot} + (1\text{-}l_{4,ot})s_{4,ot} + d_{4,ot}] + [(A_{or} l_{4,ot}) / (A_{ot} l_{4,or})] [l_{4,or} + (1\text{-}l_{4,or})s_{4,or} + d_{4,or}]\} \quad (12)$$

Inriver fishery contact rates can similarly derived based on harvest allocation inputs according to sharing goals for 50% of the total harvest to occur in the tribal fishery. Thus,

$$\sum H_{a,rt} = \sum H_{a,ot} + \sum H_{a,or} + \sum H_{a,rr} \quad (12)$$

Thus

$$\sum H_{a,rt} = \sum (H_{a,ot} + H_{a,or}) [1 + (A_{rr}/(A_{ot} + A_{or})] \quad (13)$$

Therefore,

$$c_{4,rt} = \sum (H_{a,ot} + H_{a,or}) [1 + (A_{rr}/(A_{ot} + A_{or})] [1/\sum(N_{a,rt} v_{a,rt})] \quad (14)$$

and

$$c_{4,rr} = \sum (H_{a,ot} + H_{a,or}) [A_{rr}/(A_{ot} + A_{or})] [1/\sum(N_{a,rr} v_{a,rr})] \quad (15)$$

Spawner Reduction Rate

Several fishery alternatives are defined in terms of a spawner reduction rate (R). Spawner reduction rate is defined as the proportional reduction in escapement relative to that projected in the absence of fishing:

$$R = 1 - (E_f / E_o) \quad (16)$$

where

E_f = escapement that occurs with fishing
E_o = escapement that occurs in the absence of fishing

$$E_o = \sum N_a m_a \quad (17)$$

where

N_a = number of fish in ocean population by age
m_a = proportion of ocean population that matures and returns to freshwater by age)

$$E_o = \sum [(N_a - I_{a,ot} - I_{a,or}) m_a - I_{a,rt} - I_{a,rr}] \quad (18)$$

$I_{a,ot}$ = number of fish impacted (total mortalities) ocean troll fishery by age
$I_{a,or}$ = number of fish impacted (total mortalities) ocean recreational fishery by age
$I_{a,rt}$ = number of fish impacted (total mortalities) river tribal fishery by age
$I_{a,rr}$ = number of fish impacted (total mortalities) river recreational fishery by age

Note that Prager and Mohr (2001) formulated an arithmetic solution to calculate contact rates for a prescribed spawner reduction rate but our model used a solver routine (see Appendix D) owing to the added complexity of the calculation involving multiple ocean and river fisheries as well as separate hatchery and wild components of the run.

Stock-Recruitment

The stock-recruitment relationship at the heart of the model was as decribed for Klamath fall chinook by STT (2005). Model parameters were based on the model 2 formulation described by the STT (2005) which includes an index of early life survival. The STT calculation was based on projected spawning ground recruits in the absence of fishing versus the spawners in the brood year that produced those recruits. We refit the model ocean age-3 population size using data reported by the STT (2005):

$$N_3 = \alpha\, S\, e^{-\beta S + \theta(s - \check{s}) + \varepsilon}, \quad \varepsilon \sim N(0, \sigma^2) \qquad (19)$$

where

N_3 = Number of ocean age-3 recruits (Sept 1)
S = spawners
α = Ricker parameter
β = Ricker parameter
θ = parameter related to early life suvival
s' = average cohort survival from release to age 2 (jack) return for two Klamath hatcheries.
s = ln(s')
š = mean(s')
ε = normally distributed error term
σ = error variance

Parameters were fit by linear regression from data in Sub-Appendix Table G(b)-2:

$$\text{Log}(N_3/S) = a + bS + c\,(s - \check{s}) + \varepsilon \qquad (20)$$

Regression Statistics	
Multiple R	0.893
R Square	0.797
Adjusted R Square	0.775
Standard Error	0.631
Observations	22

ANOVA

	df	*SS*	*MS*	*F*	*Signif. F*
Regression	2	29.649	14.825	37.263	2.66E-07
Residual	19	7.559	0.398		
Total	21	37.208			

	Coefficients	*Std Err*	*t Stat*	*P-value*	*Lwr 95%*	*Uppr 95%*
Intercept	2.500	0.229	10.919	0.000	2.021	2.980
X Variable 1	-1.787E-05	3.86E-06	-4.62406	0.000185	-2.6E-05	-9.8E-06
X Variable 2	0.538	0.114	4.709	0.000	0.299	0.777

Hilborn's correction to was used to correct for bias caused by the error distribution:

$$\alpha' = \alpha\, e^{\sigma 2/2} \qquad (21)$$

Note that the actual stock recruitment formulation in the stochastic stock recruitment model utilized the the Model 1 formulation with the Model 2 α' and β parameters because the two stage survival formulation of model 2 was not necessary in prospective simulations and because the one-stage application simplified representation of potentially-covarying survivals.

$$N_3 = \alpha'\, S\, e^{-\beta S + \varepsilon'}, \quad \varepsilon' \sim N(0, \sigma'^2) \qquad (22)$$

ε'= normally distributed error term based on residual error in data relative to eqn. 2 with parameters derived using eqn 10 and 21 (Sub-Appendix Table G(b)-3).

σ'^2 = error variance corresponding to ε'

Sub-Appendix Table G(b)-2. Stock recruitment and early life survival index data for Klamath Fall Chinook (SST 2005).

BY	S	N_3 (sept1)	N_3/S	$Ln(N_3/S)$	s'	s	s-s(avg)
1979	30,637	423,701	13.8	2.6	0.0540	-2.9	1.51
1980	21,484	236,144	11.0	2.4	0.0140	-4.3	0.16
1981	33,857	106,338	3.1	1.1	0.0202	-3.9	0.53
1982	31,951	277,850	8.7	2.2	0.0081	-4.8	-0.39
1983	30,784	776,743	25.2	3.2	0.0625	-2.8	1.66
1984	16,064	512,171	31.9	3.5	0.0405	-3.2	1.22
1985	25,676	391,378	15.2	2.7	0.0450	-3.1	1.33
1986	113,359	256,532	2.3	0.8	0.0044	-5.4	-1.00
1987	101,717	148,910	1.5	0.4	0.0038	-5.6	-1.14
1988	79,395	37,029	0.5	-0.8	0.0024	-6.0	-1.60
1989	43,869	33,368	0.8	-0.3	0.0004	-7.8	-3.40
1990	15,596	85,146	5.5	1.7	0.0298	-3.5	0.91
1991	11,649	91,590	7.9	2.1	0.0099	-4.6	-0.19
1992	12,029	526,545	43.8	3.8	0.0528	-2.9	1.49
1993	21,858	177,305	8.1	2.1	0.0023	-6.1	-1.65
1994	32,333	99,535	3.1	1.1	0.0043	-5.4	-1.02
1995	161,793	72,062	0.4	-0.8	0.0040	-5.5	-1.09
1996	81,326	74,965	0.9	-0.1	0.0083	-4.8	-0.36
1997	46,144	327,575	7.1	2.0	0.0597	-2.8	1.61
1998	42,488	253,386	6.0	1.8	0.0128	-4.4	0.07
1999	18,456	406,036	22.0	3.1	0.0264	-3.6	0.79
2000	82,729	386,121	4.7	1.5	0.0211	-3.8	0.57
average	47,963	259,110	10.152	1.643	0.0221	-4.4	
min	11,649	33,368	0.445	-0.809	0.0004	-7.8	
max	161,793	776,743	43.773	3.779	0.0625	-2.8	
std	39,160	193,533	11.338	1.331	0.0209	1.3	
cv	0.82	0.75	1.12	0.81	0.95	-0.30	

Sub-Appendix Table G(b)-3. Residual error in stock-recruitment data (observed) based on our single stage error term model (predicted).

BY	S	Ln(N_3/S) Observed	Ln(N_3/S) Predicted	Residual	Residual^2
1979	30,637	2.6	1.95	0.674	0.454
1980	21,484	2.4	2.12	0.281	0.079
1981	33,857	1.1	1.90	-0.751	0.564
1982	31,951	2.2	1.93	0.234	0.055
1983	30,784	3.2	1.95	1.278	1.633
1984	16,064	3.5	2.21	1.249	1.560
1985	25,676	2.7	2.04	0.683	0.466
1986	113,359	0.8	0.47	0.342	0.117
1987	101,717	0.4	0.68	-0.302	0.091
1988	79,395	-0.8	1.08	-1.844	3.401
1989	43,869	-0.3	1.72	-1.990	3.960
1990	15,596	1.7	2.22	-0.524	0.275
1991	11,649	2.1	2.29	-0.230	0.053
1992	12,029	3.8	2.29	1.494	2.231
1993	21,858	2.1	2.11	-0.016	0.000
1994	32,333	1.1	1.92	-0.798	0.637
1995	161,793	-0.8	-0.39	-0.418	0.175
1996	81,326	-0.1	1.05	-1.129	1.274
1997	46,144	2.0	1.68	0.284	0.081
1998	42,488	1.8	1.74	0.045	0.002
1999	18,456	3.1	2.17	0.921	0.848
2000	82,729	1.5	1.02	0.519	0.269
				MSE	0.9112

Stock-Recruitment Autocorrelation

Autocorrelation in stock-recruitment residuals was estimated as follows:

$$Z_t = Ø\, Z_{t-1} + \varepsilon_t, \qquad \varepsilon_t \sim N(0, \sigma_e^2) \qquad (23)$$

where

Z_t = autocorrelation residual
Ø = lag autoregression coeeficient
ε_t = autocorrelation error
σ_e^2= autocorrelation error variance

The autocorrelation error variance (σ_e^2) is related to the stock-recruitment error variance (σ_z^2) with the lag autoregression coeeficient:

$$\sigma_e^2 = \sigma_z^2\,(1- Ø^2) \qquad (24)$$

Model simulations using the autocorrelated residual options were seeded in the first year with a randomly generated value from $N(0, \sigma_z^2)$.

The lag autoregression coeeficient was estimated using a linear regression based on eqn 23:

	Residual error		
BY	observed	Lag 1	regression
1979	0.674		
1980	0.281	0.674	-0.047
1981	-0.751	0.281	-0.887
1982	0.234	-0.751	0.599
1983	1.278	0.234	1.164
1984	1.249	1.278	0.627
1985	0.683	1.249	0.075
1986	0.342	0.683	0.010
1987	-0.302	0.342	-0.468
1988	-1.844	-0.302	-1.698
1989	-1.990	-1.844	-1.093
1990	-0.524	-1.990	0.444
1991	-0.230	-0.524	0.025
1992	1.494	-0.230	1.606
1993	-0.016	1.494	-0.743
1994	-0.798	-0.016	-0.790
1995	-0.418	-0.798	-0.030
1996	-1.129	-0.418	-0.925
1997	0.284	-1.129	0.833
1998	0.045	0.284	-0.094
1999	0.921	0.045	0.899
2000	0.519	0.921	0.071

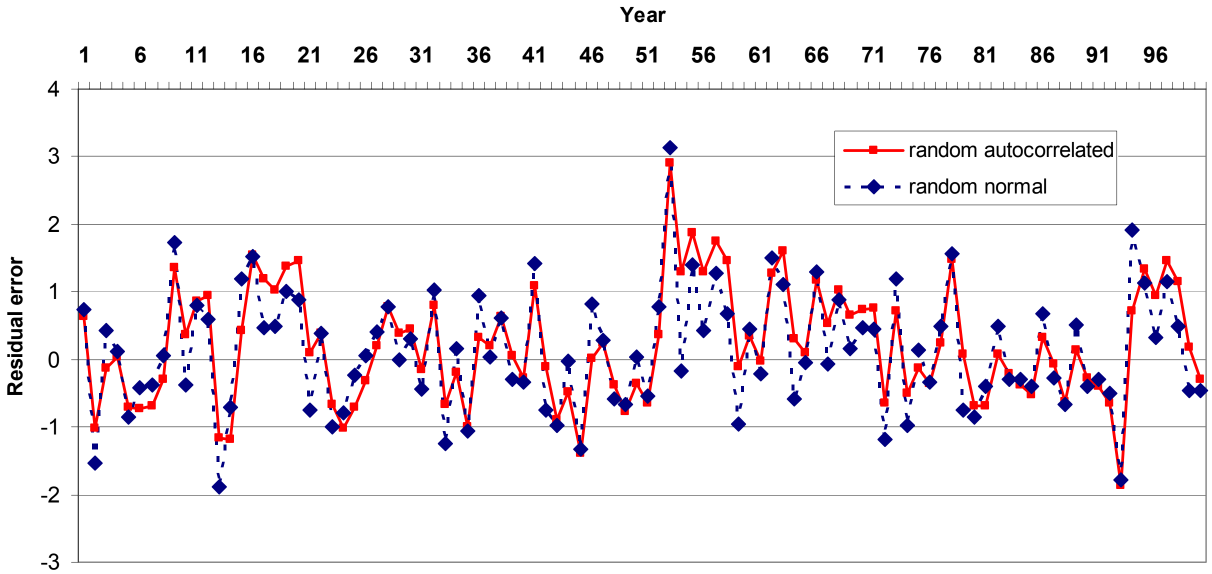
SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.488
R Square	0.238
Adjusted R Square	0.188
Standard Error	0.822
Observations	21

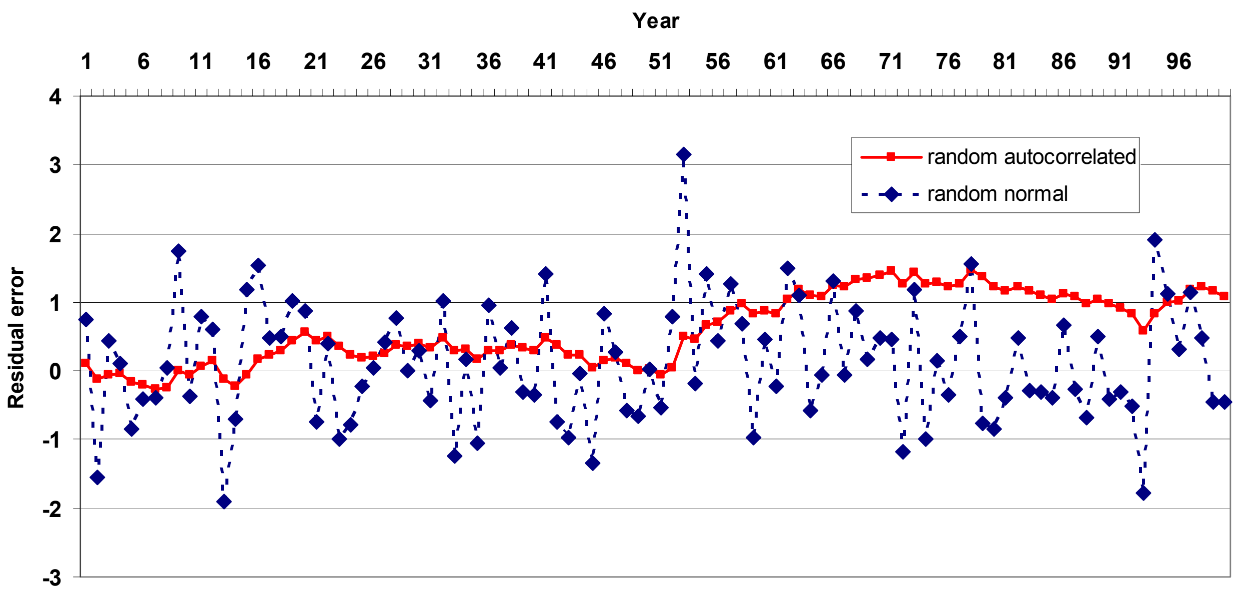
ANOVA

	df	*SS*	*MS*	*F*	*Signif F*
Regression	1	4.225	4.225	6.248	0.022
Residual	20	13.523	0.676		
Total	21	17.747			

	Coefficients	*Std err*	*t Stat*	*P-value*	*Lwr 95%*	*Upr 95%*
Intercept	0	#N/A	#N/A	#N/A	#N/A	#N/A
X Variable 1	0.486	0.194	2.506	0.021	0.082	0.891



Sub-Appendix Figure G(b)-1. Example of autocorrelation effect on randomly-generated residual error patterns (Ø = 0.5, σ_z^2 = 0.91).



Sub-Appendix Figure G(b)-2. Example of autocorrelation effect on randomly-generated residual error patterns (Ø = 0.99, σ_z^2 = 0.91).

Stock Recruitment Depensation

Depensation is applied to the stock-recruitment function estimate of recruits per spawners as follows:

$$N_3' = N_3 * (1 - Exp((Log(1 - 0.95) / (\gamma - 1)) * S)) \quad (25)$$

where

N_3' = Number of ocean age-3 recruits (Sept 1) after depensation applied,
N_3 = N umber of ocean age-3 recruits (Sept 1) estimated from stock-recruitment function,
S = spawners,
γ = Depensation threshold (spawner number),

Forecast Error

Forecast error based on differences between preseason forecast and postseason estimates for ocean abundance by age (Sub-Appendix Table G(b)-4). This variance was estimate:

$$Y = x + \varepsilon \qquad \varepsilon \sim N(0, \sigma_e^2) \quad (26)$$

$$\sigma_e = \text{stdev } [(y\text{-}x) / x] \quad (27)$$

Fishery Variance

The fishery implementation variance was based on differences between preseason forecast and postseason estimates for age-4 fish in combined ocean fisheries (Sub-Appendix Table G(b)-4). This variance was estimate:

$$Y = x + \varepsilon) \qquad \varepsilon \sim N(0, \sigma_e^2) \quad (28)$$

$$\sigma_e = \text{stdev } (y/x) \quad (29)$$

where

$$y/x \sim N(1, \sigma_e^2)$$

Sub-Appendix Table G(b)-4. Preseason target and postseason ocean harvest rates and ocean abundance forecasts for Klamath fall Chinook.

	ocn age-4 harv rate			Age-3 forecast			Age-4 forecast			Age-5 forecast		
	pre	post	pre /post	pre	post	(pr-po) /po	pre	post	(pr-po) /po	pre	post	(pr-po) /po
1985				113,000	276,000	-0.59	56875	57500	-0.01			
1986	0.28	0.46	0.61	426,000	1,308,678	-0.67	66250	141173	-0.53			
1987	0.28	0.43	0.65	511,800	783,001	-0.35	206125	343562	-0.40	5250	19531	-0.73
1988	0.31	0.39	0.79	370,800	758,625	-0.51	186375	236159	-0.21	13250	14725	-0.10
1989	0.30	0.35	0.86	450,600	367,979	0.22	215500	178110	0.21	10125	9658	0.05
1990	0.30	0.55	0.55	479,000	176,803	1.71	50125	103324	-0.51	7625	7806	-0.02
1991	0.13	0.18	0.72	176,200	69,609	1.53	44625	37308	0.20	1500	2786	-0.46
1992	0.06	0.07	0.86	50,000	39,637	0.26	44750	28261	0.58	1250	1448	-0.14
1993	0.12	0.16	0.75	294,400	168,858	0.74	39125	15091	1.59	1125	1767	-0.36
1994	0.07	0.09	0.78	138,000	120,329	0.15	86125	41821	1.06	500	1468	-0.66
1995	0.07	0.14	0.50	269,000	784,221	-0.66	47000	28827	0.63	2000	3917	-0.49
1996	0.17	0.16	1.06	479,800	190,977	1.51	268500	225886	0.19	1125	789	0.43
1997	0.10	0.06	1.67	224,600	140,784	0.60	53875	63019	-0.15	7875	8891	-0.11
1998	0.07	0.09	0.78	176,000	154,679	0.14	46000	45039	0.02	3250	2399	0.35
1999	0.10	0.09	1.11	84,800	129,696	-0.35	78750	30259	1.60	2000	2114	-0.05
2000	0.11	0.10	1.10	349,600	618,688	-0.43	38875	44462	-0.13	1375	860	0.60
2001	0.14	0.09	1.56	187,200	358,169	-0.48	247000	134245	0.84	1250	259	3.83
2002	0.13	0.15	0.87	209,000	565,734	-0.63	143800	99993	0.44	9700	6963	0.39
2003	0.16	0.23	0.70	171,300	540,668	-0.68	132400	220224	-0.40	6500	2062	2.15
2004	0.15	0.51	0.29	72,100	159,242	-0.55	134500	166527	-0.19	9700	28878	-0.66
2005	0.08	0.24	0.33	185,700	209,493	-0.11	48900	34791	0.41	5200	7433	-0.30
2006				44,100			63700			2200		
avg	0.16	0.23	0.83	265,295	382,294	0.07	108,930	110,904	0.26	4,640	6,513	0.19
std	0.09	0.16	0.35	146,211	332,382	0.78	77,093	91,914	0.64	3,943	7,489	1.09
cv	0.56	0.71	0.42	0.55	0.87	10.80	0.71	0.83	2.43	0.85	1.15	5.61

[1] *Annual rates for Sept 1 – Aug 31 from (PFMC 2006b)*

Sub-Appendix C –Model Outputs

Sub-Appendix Table G(c)-5. Simulation of population dynamics with no fishing.

Model Inputs

Population

Iterations	200		
print all (0= no, 1 = yes)	1		
Initial population size (spnrs)			
2 years ago	24,100		
1 year ago	27,300		
Yr 1 ocean recruits	total #	p Hatch	
age 3	44,100	0.67	
age 4	63,700	0.55	
age 5	2,200	0.72	
Stock Recruitment Function			
alpha	14.87		
beta	1.787E-05		
spawners @ max constraint	162,000		
max recruits constraint	777,000		
Depensation (0=no, 1=yes)	1		
theshold escapement	35000		
Recr variation (ocean)	2		
0 = deterministic			
1 = random (log) normal	MSE :	0.91	
2 = random autocorrelated	coef:	0.5	
Freshwater production trend	0		
Age-specific maturity rate			
Age 3	0.379		
Age 4	0.883		
Age 5	1.000		
Ocean winter survival rate			
age 3	0.58		
age 4	0.8		
age 5	0.8		
Hatchery fish			
Annual releases (millions)	8.9		
SAR	0.007		
p natural spawning	0.1		
egg take goal (millions)	16		
eggs/spawner	1,250		

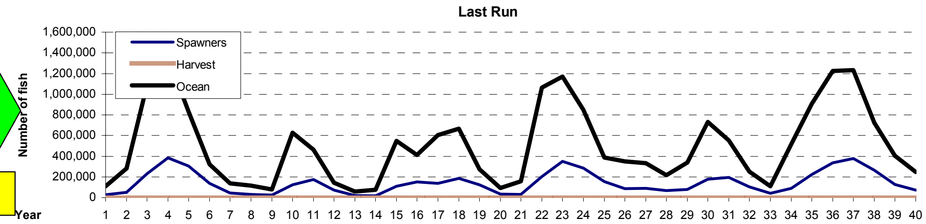
Fishery

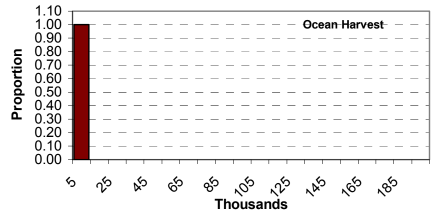
Fishing strategy	1	ref rate	ref esc	other
1 = fixed rate		0.000		
2 = Fish Management Plan		0.67	35000	
3 = de min (fixed)		0		
Rebuilding? (0 or 1)	0			
ESA Limit? (0 or 1)	1			
max impact		0.17		
transfer harv?		1		
River sport limitations				
max harv rate		0.12		
max catch		20,000		
Forecast uncertainty	var	corr		
age 3	0.5	-0.5		
age 4	0.4			
age 5	1.2			
Implementation uncertainty				
CV	0.5			
Bias	1			
Fishery allocation				
ocean troll	0.3400			
ocean recreational	0.0850			
river tribal	0.5000			
river recreational	0.0750			
Ocean troll	vulner	legal	C&R	
age 3	0.25	0.80	0.26	
age 4	1.00	0.95	0.26	
age 5	2.00	1.00	0.26	
dropoff mort rate				0.05
Ocean recreational	vulner	legal	C&R	
age 3	0.50	0.99	0.14	
age 4	1.00	1	0.14	
age 5	2.00	1	0.14	
dropoff mort rate				0.05
RiverTribal	vulner	retain	C&R	
age 3	0.50	1	0	
age 4	1.00	1	0	
age 5	1.60	1	0	
dropoff mort rate				0.08
River recreational	vulner	retain	C&R	
age 3	1.40	1	0	
age 4	1	1	0	
age 5	0.95	1	0	
dropoff mort rate				0.02

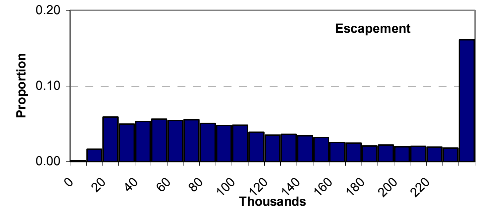
Run

Reset

Model Outputs







	1-5 yrs				> 5 yrs				1-40 yr (avg)	
	avg	*cv*	*min*	*max*	*avg*	*cv*	*min*	*max*	*all*	*demin*
Numbers (H+W)										
Ocean	414,616	0.83	20,766	1,483,291	499,435	0.69	18,608	1,589,543	488,832	0
River	142,908	0.79	9,344	519,430	179,658	0.65	7,067	571,574	175,064	0
Spawn naturally	109,487	0.86	7,509	196,111	141,010	0.66	4,189	407,662	137,069	0
Hatchery rack	42,974		1,433	400,302	50,884		799	306,815	49,895	0
% hatchery					27%				27%	
Harvest (H+W)										
Ocean troll	0	0.00	0	0	0	0.00	0	0	0	0
Ocean sport	0	0.00	0	0	0	0.00	0	0	0	0
subtotal	*0*				*0*				*0*	*0*
River tribal	0	0.00	0	0	0	0.00	0	0	0	0
River sport	0	0.00	0	0	0	0.00	0	0	0	0
subtotal	*0*				*0*				*0*	*0*
	0				0				0	0
Fishery rates										
Harvest rate	0.000	--	0.000	0.000	0.000	--	0.000	0.000	0.000	0.000
Impact rate	0.000	--	0.000	0.000	0.000	--	0.000	0.000	0.000	0.000
Age 4 ocn imp	0.000	--	0.000	0.000	0.000	--	0.000	0.000	0.000	0.000
Spnr Reduc rate	0.315	--	0.214	0.414	0.311	--	0.206	0.414	0.312	0.000
Tribal harv share	0.000	--	1.000	0.000	0.000	--	1.000	0.000	0.000	0.000

Escapement			
Frequencies	**1-5yrs**	**6-40 yrs**	**1-40 yrs**
yrs(E < 35,000)	0.299	0.074	0.102
yrs(E < 21,000)	0.031	0.019	0.021
yrs(E < 12,000)	0.006	0.003	0.003
iter(3yrs <35,000)	--	--	0.280
freq (2yrs<35000)	1.46	1.11	2.6
freq (3yrs<35000)	0.46	0.39	0.8
yrs(E trib <720)	0.124	0.051	0.060

Fishery			
Frequencies	**1-5yrs**	**6-40 yrs**	**1-40 yrs**
yrs(de min fishery)	0.000	0.000	0.000
yrs(ocn 4 IR > 0.17)	0.000	0.000	0.000
yrs(ocn 4 IR <= 0.05	1.000	1.000	1.000
yrs(egg take goal)	0.892	0.862	0.866
yrs(0%< rt<50%)	0.000	0.000	0.000
freq(OverfishEvent)			1.3

Sub-Appendix Table G(c)-6. Fish Management Plan only (under past management practices which resulted in actual ocean fishing rates which averaged greater than the target values).

Model Inputs

Population

Iterations	200	
print all (0= no, 1 = yes)	1	
Initial population size (spnrs)		
2 years ago	24,100	
1 year ago	27,300	
Yr 1 ocean recruits	total #	p Hatch
age 3	44,100	0.67
age 4	63,700	0.55
age 5	2,200	0.72
Stock Recruitment Function		
alpha	14.87	
beta	1.787E-05	
spawners @ max constraint	162,000	
max recruits constraint	777,000	
Depensation (0=no, 1=yes)	1	
theshold escapement	35000	
Recr variation (ocean)	2	
0 = deterministic		
1 = random (log) normal	MSE :	0.91
2 = random autocorrelated	coef:	0.5
Freshwater production trend	0	
Age-specific maturity rate		
Age 3	0.379	
Age 4	0.883	
Age 5	1.000	
Ocean winter survival rate		
age 3	0.58	
age 4	0.8	
age 5	0.8	
Hatchery fish		
Annual releases (millions)	8.9	
SAR	0.007	
p natural spawning	0.1	
egg take goal (millions)	16	
eggs/spawner	1,250	

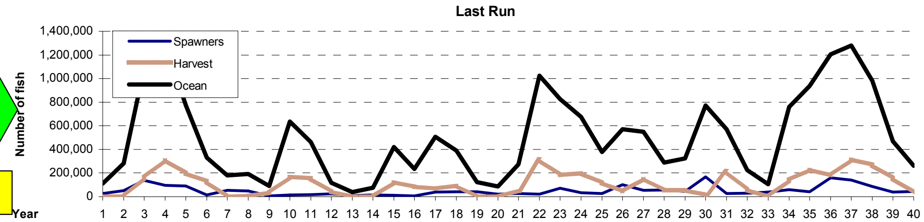
Fishery

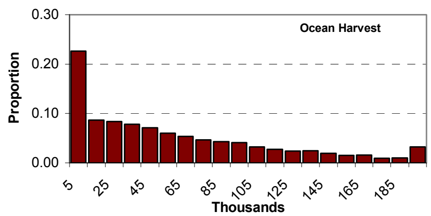
Fishing strategy	2	ref rate	ref esc	other
1 = fixed rate		0.000		
2 = Fish Management Plan		0.67	35000	
3 = de min (fixed)		0		
Rebuilding? (0 or 1)	0			
ESA Limit? (0 or 1)	0			
max impact		0.17		
transfer harv?		1		
River sport limitations				
max harv rate		0.12		
max catch		20,000		
Forecast uncertainty	var	corr		
age 3	0.5	-0.5		
age 4	0.4			
age 5	1.2			
Implementation uncertainty				
CV	0.5			
Bias	1.3			
Fishery allocation				
ocean troll	0.3400			
ocean recreational	0.0850			
river tribal	0.5000			
river recreational	0.0750			
Ocean troll	vulner	legal	C&R	
age 3	0.25	0.80	0.26	
age 4	1.00	0.95	0.26	
age 5	2.00	1.00	0.26	
dropoff mort rate				0.05
Ocean recreational	vulner	legal	C&R	
age 3	0.50	0.99	0.14	
age 4	1.00	1	0.14	
age 5	2.00	1	0.14	
dropoff mort rate				0.05
RiverTribal	vulner	retain	C&R	
age 3	0.50	1	0	
age 4	1.00	1	0	
age 5	1.60	1	0	
dropoff mort rate				0.08
River recreational	vulner	retain	C&R	
age 3	1.40	1	0	
age 4	1	1	0	
age 5	0.95	1	0	
dropoff mort rate				0.02

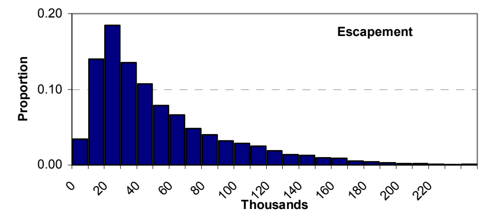
Run

Reset

Model Outputs







	1-5 yrs				*> 5 yrs*				*1-40 yr (avg)*	
	avg	*cv*	*min*	*max*	*avg*	*cv*	*min*	*max*	*all*	*demin*
Numbers (H+W)										
Ocean	397,150	0.85	20,766	1,670,634	508,644	0.68	15,602	1,515,476	494,707	0
River	103,451	0.72	9,344	414,141	128,924	0.61	8,662	454,055	125,740	0
Spawn naturally	45,141	0.79	4,627	292,964	54,518	0.75	4,418	289,876	53,346	0
Hatchery rack	24,508		1,099	234,579	25,326		799	301,363	25,223	0
% hatchery					32%				32%	
Harvest (H+W)										
Ocean troll	29,668	1.34	0	249,668	45,238	0.93	0	235,766	43,292	0
Ocean sport	11,195	1.35	0	100,841	16,326	0.95	0	89,428	15,684	0
subtotal	*40,863*				*61,564*				*58,976*	*0*
River tribal	33,559	1.20	0	236,371	48,837	0.86	0	276,011	46,927	0
River sport	5,334	1.13	0	20,000	8,011	0.78	0	20,000	7,676	0
subtotal	*38,892*				*56,848*				*54,603*	*0*
	79,755				118,412				113,580	0
Fishery rates										
Harvest rate	0.153	--	0.000	0.554	0.213	--	0.000	0.600	0.206	0.000
Impact rate	0.164	--	0.000	0.590	0.229	--	0.000	0.640	0.221	0.000
Age 4 ocn imp	0.202	--	0.000	0.653	0.272	--	0.000	0.653	0.263	0.000
Spnr Reduc rate	0.583	--	0.228	0.959	0.686	--	0.207	0.961	0.673	0.000
Tribal harv share	0.449	--	0.114	0.899	0.426	--	0.104	0.908	0.429	0.000

Escapement

Frequencies	1-5yrs	6-40 yrs	1-40 yrs
yrs(E < 35,000)	0.560	0.414	0.432
yrs(E < 21.000)	0.200	0.190	0.191
yrs(E < 12,000)	0.047	0.059	0.057
iter(3yrs <35,000)	--	--	0.930
freq (2yrs<35000)	2.28	8.08	10.4
freq (3yrs<35000)	1.13	5.08	6.2
yrs(E trib <720)	0.290	0.247	0.252

Fishery

Frequencies	1-5yrs	6-40 yrs	1-40 yrs
yrs(de min fishery)	0.000	0.000	0.000
yrs(ocn 4 IR > 0.17)	0.497	0.697	0.672
yrs(ocn 4 IR <= 0.05	0.340	0.152	0.176
yrs(egg take goal)	0.726	0.633	0.645
yrs(0%< rt<50%)	0.636	0.737	0.727
freq(OverfishEvent)			3.5

Sub-Appendix Table G(c)-7. **Fish Management Plan only (under current management practices where actual ocean fishing rates are expected to average target values).**

Model Inputs

Population

Iterations	200	
print all (0= no, 1 = yes)	1	
Initial population size (spnrs)		
2 years ago	24,100	
1 year ago	27,300	
Yr 1 ocean recruits	total #	p Hatch
age 3	44,100	0.67
age 4	63,700	0.55
age 5	2,200	0.72
Stock Recruitment Function		
alpha	14.87	
beta	1.787E-05	
spawners @ max constraint	162,000	
max recruits constraint	777,000	
Depensation (0=no, 1=yes)	1	
theshold escapement	35000	
Recr variation (ocean)	2	
0 = deterministic		
1 = random (log) normal	MSE :	0.91
2 = random autocorrelated	coef:	0.5
Freshwater production trend	0	
Age-specific maturity rate		
Age 3	0.379	
Age 4	0.883	
Age 5	1.000	
Ocean winter survival rate		
age 3	0.58	
age 4	0.8	
age 5	0.8	
Hatchery fish		
Annual releases (millions)	8.9	
SAR	0.007	
p natural spawning	0.1	
egg take goal (millions)	16	
eggs/spawner	1,250	

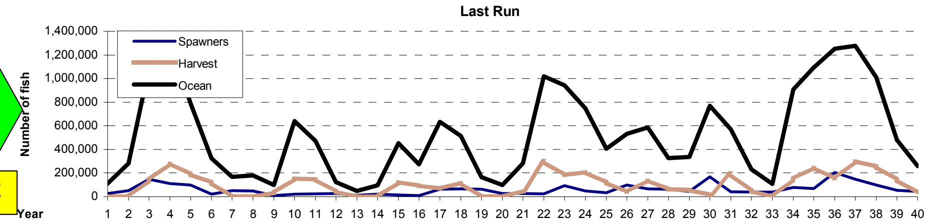
Fishery

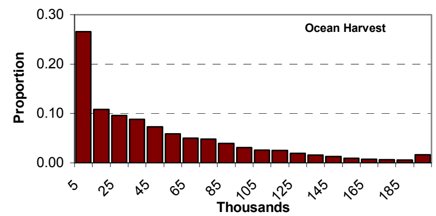
Fishing strategy	2	ref rate	ref esc	other
1 = fixed rate		0.000		
2 = Fish Management Plan		0.67	35000	
3 = de min (fixed)		0		
Rebuilding? (0 or 1)	0			
ESA Limit? (0 or 1)	0			
max impact		0.17		
transfer harv?		1		
River sport limitations				
max harv rate		0.12		
max catch		20,000		
Forecast uncertainty	var	corr		
age 3	0.5	-0.5		
age 4	0.4			
age 5	1.2			
Implementation uncertainty				
CV	0.5			
Bias	1			
Fishery allocation				
ocean troll	0.3400			
ocean recreational	0.0850			
river tribal	0.5000			
river recreational	0.0750			
Ocean troll	vulner	legal	C&R	
age 3	0.25	0.80	0.26	
age 4	1.00	0.95	0.26	
age 5	2.00	1.00	0.26	
dropoff mort rate				0.05
Ocean recreational	vulner	legal	C&R	
age 3	0.50	0.99	0.14	
age 4	1.00	1	0.14	
age 5	2.00	1	0.14	
dropoff mort rate				0.05
RiverTribal	vulner	retain	C&R	
age 3	0.50	1	0	
age 4	1.00	1	0	
age 5	1.60	1	0	
dropoff mort rate				0.08
River recreational	vulner	retain	C&R	
age 3	1.40	1	0	
age 4	1	1	0	
age 5	0.95	1	0	
dropoff mort rate				0.02

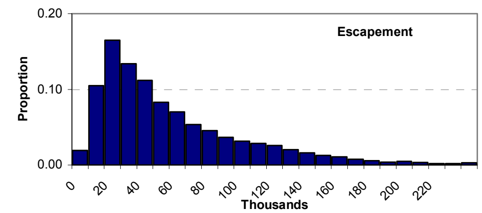
Run

Reset

Model Outputs







	1-5 yrs				*> 5 yrs*				*1-40 yr (avg)*	
	avg	*cv*	*min*	*max*	*avg*	*cv*	*min*	*max*	*all*	*demin*
Numbers (H+W)										
Ocean	400,988	0.85	20,766	1,560,592	520,495	0.66	17,455	1,570,209	505,556	0
River	111,678	0.74	9,344	432,546	143,147	0.61	9,517	469,384	139,213	0
Spawn naturally	50,017	0.80	5,803	252,604	62,354	0.73	5,292	323,621	60,812	0
Hatchery rack	25,557		1,133	252,193	26,523		799	288,159	26,403	0
% hatchery					30%				30%	
Harvest (H+W)										
Ocean troll	23,441	1.43	0	222,632	36,789	0.98	0	223,312	35,121	0
Ocean sport	8,746	1.43	0	92,004	13,126	1.01	0	89,229	12,579	0
subtotal	*32,187*				*49,916*				*47,699*	*0*
River tribal	35,242	1.21	0	246,982	52,844	0.85	0	269,955	50,644	0
River sport	5,607	1.12	0	20,000	8,572	0.75	0	20,000	8,201	0
subtotal	*40,849*				*61,416*				*58,845*	*0*
	73,036				111,331				106,544	0
Fishery rates										
Harvest rate	0.139	--	0.000	0.539	0.198	--	0.000	0.579	0.191	0.000
Impact rate	0.149	--	0.000	0.575	0.213	--	0.000	0.618	0.205	0.000
Age 4 ocn imp	0.156	--	0.000	0.653	0.215	--	0.000	0.653	0.207	0.000
Spnr Reduc rate	0.564	--	0.227	0.948	0.666	--	0.208	0.956	0.653	0.000
Tribal harv share	0.505	--	0.129	0.895	0.483	--	0.116	0.899	0.485	0.000

Escapement			
Frequencies	**1-5yrs**	**6-40 yrs**	**1-40 yrs**
yrs(E < 35,000)	0.517	0.336	0.359
yrs(E < 21.000)	0.163	0.135	0.138
yrs(E < 12,000)	0.034	0.035	0.035
iter(3yrs <35,000)	--	--	0.865
freq (2yrs<35000)	2.17	6.05	8.2
freq (3yrs<35000)	1.07	3.59	4.7
yrs(E trib <720)	0.258	0.199	0.206

Fishery			
Frequencies	**1-5yrs**	**6-40 yrs**	**1-40 yrs**
yrs(de min fishery)	0.000	0.000	0.000
yrs(ocn 4 IR > 0.17)	0.395	0.576	0.553
yrs(ocn 4 IR <= 0.05	0.387	0.185	0.210
yrs(egg take goal)	0.751	0.654	0.666
yrs(0%< rt<50%)	0.493	0.569	0.562
freq(OverfishEvent)			2.9

Sub-Appendix Table G(c)-8. Fish management plan with 16% limit on ocean harvest rate (17% impact rate) and 0% *de minimis* fishing rate. (Status quo management)

Model Inputs

Population

Iterations	200	
print all (0= no, 1 = yes)	1	
Initial population size (spnrs)		
2 years ago	24,100	
1 year ago	27,300	
Yr 1 ocean recruits	total #	p Hatch
age 3	44,100	0.67
age 4	63,700	0.55
age 5	2,200	0.72
Stock Recruitment Function		
alpha	14.87	
beta	1.787E-05	
spawners @ max constraint	162,000	
max recruits constraint	777,000	
Depensation (0=no, 1=yes)	1	
theshold escapement	35000	
Recr variation (ocean)	2	
0 = deterministic		
1 = random (log) normal	MSE :	0.91
2 = random autocorrelated	coef:	0.5
Freshwater production trend	0	
Age-specific maturity rate		
Age 3	0.379	
Age 4	0.883	
Age 5	1.000	
Ocean winter survival rate		
age 3	0.58	
age 4	0.8	
age 5	0.8	
Hatchery fish		
Annual releases (millions)	8.9	
SAR	0.007	
p natural spawning	0.1	
egg take goal (millions)	16	
eggs/spawner	1,250	

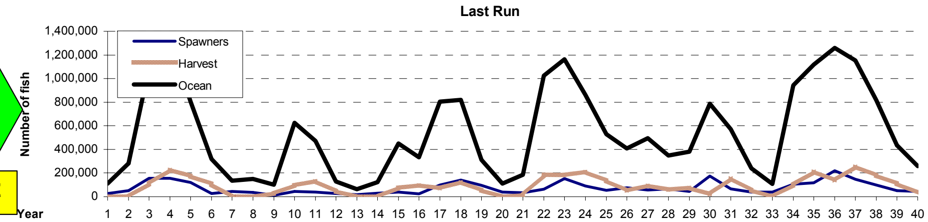
Fishery

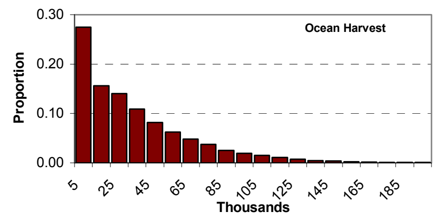
Fishing strategy	2	ref rate	ref esc	other
1 = fixed rate		0.000		
2 = Fish Management Plan		0.67	35000	
3 = de min (fixed)		0		
Rebuilding? (0 or 1)	0			
ESA Limit? (0 or 1)	1			
max impact		0.17		
transfer harv?		1		
River sport limitations				
max harv rate		0.12		
max catch		20,000		
Forecast uncertainty	var	corr		
age 3	0.5	-0.5		
age 4	0.4			
age 5	1.2			
Implementation uncertainty				
CV	0.5			
Bias	1			
Fishery allocation				
ocean troll	0.3400			
ocean recreational	0.0850			
river tribal	0.5000			
river recreational	0.0750			
Ocean troll	vulner	legal	C&R	
age 3	0.25	0.80	0.26	
age 4	1.00	0.95	0.26	
age 5	2.00	1.00	0.26	
dropoff mort rate				0.05
Ocean recreational	vulner	legal	C&R	
age 3	0.50	0.99	0.14	
age 4	1.00	1	0.14	
age 5	2.00	1	0.14	
dropoff mort rate				0.05
RiverTribal	vulner	retain	C&R	
age 3	0.50	1	0	
age 4	1.00	1	0	
age 5	1.60	1	0	
dropoff mort rate				0.08
River recreational	vulner	retain	C&R	
age 3	1.40	1	0	
age 4	1	1	0	
age 5	0.95	1	0	
dropoff mort rate				0.02

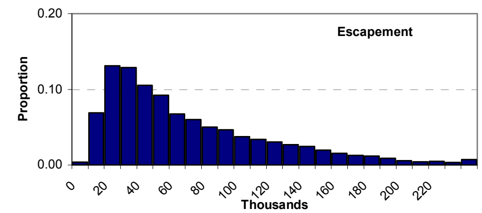
Run

Reset

Model Outputs







	1-5 yrs				> 5 yrs				1-40 yr (avg)	
	avg	*cv*	*min*	*max*	*avg*	*cv*	*min*	*max*	*all*	*demin*
Numbers (H+W)										
Ocean	405,970	0.85	20,766	1,560,592	531,318	0.65	19,602	1,682,953	515,650	0
River	122,095	0.77	9,344	487,489	160,171	0.61	8,090	487,001	155,412	0
Spawn naturally	58,001	0.81	7,509	262,655	74,507	0.68	4,827	325,749	72,443	0
Hatchery rack	27,961		1,433	257,407	29,419		799	195,287	29,237	0
% hatchery					28%				29%	
Harvest (H+W)										
Ocean troll	15,523	1.35	0	121,811	25,656	0.92	0	150,385	24,390	0
Ocean sport	5,563	1.31	0	46,106	8,853	0.92	0	53,476	8,442	0
subtotal	*21,086*				*34,510*				*32,832*	*0*
River tribal	33,012	1.20	0	226,764	51,095	0.82	0	243,246	48,835	0
River sport	8,331	1.00	0	20,000	12,605	0.61	0	20,000	12,071	0
subtotal	*41,343*				*63,700*				*60,906*	*0*
	62,429				98,210				93,737	0
Fishery rates										
Harvest rate	0.124	--	0.000	0.538	0.180	--	0.000	0.558	0.173	0.000
Impact rate	0.133	--	0.000	0.573	0.192	--	0.000	0.595	0.185	0.000
Age 4 ocn imp	0.103	--	0.000	0.400	0.146	--	0.000	0.493	0.140	0.000
Spnr Reduc rate	0.542	--	0.227	0.901	0.637	--	0.214	0.903	0.625	0.000
Tribal harv share	0.525	--	0.129	0.862	0.507	--	0.122	0.886	0.510	0.000

Escapement			
Frequencies	**1-5yrs**	**6-40 yrs**	**1-40 yrs**
yrs(E < 35,000)	0.461	0.244	0.271
yrs(E < 21.000)	0.131	0.074	0.081
yrs(E < 12,000)	0.019	0.009	0.011
iter(3yrs <35,000)	--	--	0.700
freq (2yrs<35000)	1.96	4.11	6.1
freq (3yrs<35000)	0.89	2.32	3.2
yrs(E trib <720)	0.221	0.139	0.149

Fishery			
Frequencies	**1-5yrs**	**6-40 yrs**	**1-40 yrs**
yrs(de min fishery)	0.000	0.000	0.000
yrs(ocn 4 IR > 0.17)	0.264	0.407	0.389
yrs(ocn 4 IR <= 0.05	0.398	0.196	0.221
yrs(egg take goal)	0.775	0.695	0.705
yrs(0%< rt<50%)	0.416	0.469	0.463
freq(OverfishEvent)			2.2

Sub-Appendix Table G(c)-9. Fish management plan with 16% limit on ocean harvest rate (17% impact rate) and 5% *de minimis* fishing rate.

Model Inputs

Population

Iterations	200	
print all (0= no, 1 = yes)	1	
Initial population size (spnrs)		
2 years ago	24,100	
1 year ago	27,300	
Yr 1 ocean recruits	total #	p Hatch
age 3	44,100	0.67
age 4	63,700	0.55
age 5	2,200	0.72
Stock Recruitment Function		
alpha	14.87	
beta	1.787E-05	
spawners @ max constraint	162,000	
max recruits constraint	777,000	
Depensation (0=no, 1=yes)	1	
theshold escapement	35000	
Recr variation (ocean)	2	
0 = deterministic		
1 = random (log) normal	MSE :	0.91
2 = random autocorrelated	coef:	0.5
Freshwater production trend	0	
Age-specific maturity rate		
Age 3	0.379	
Age 4	0.883	
Age 5	1.000	
Ocean winter survival rate		
age 3	0.58	
age 4	0.8	
age 5	0.8	
Hatchery fish		
Annual releases (millions)	8.9	
SAR	0.007	
p natural spawning	0.1	
egg take goal (millions)	16	
eggs/spawner	1,250	

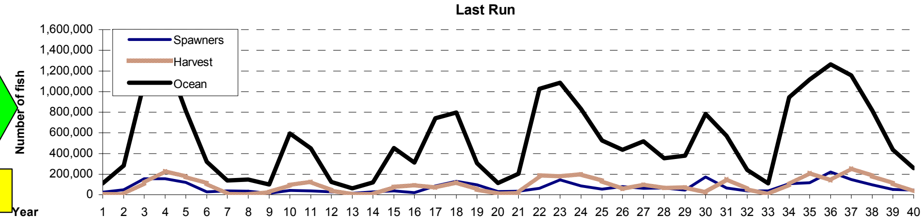
Fishery

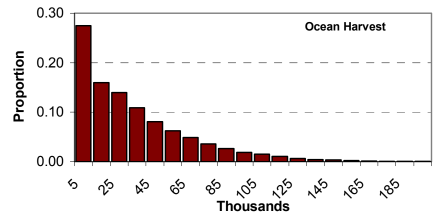
Fishing strategy	3	ref rate	ref esc	other
1 = fixed rate		0.000		
2 = Fish Management Plan		0.67	35000	
3 = de min (fixed)		0.05		
Rebuilding? (0 or 1)	0			
ESA Limit? (0 or 1)	1			
max impact		0.17		
transfer harv?		1		
River sport limitations				
max harv rate		0.12		
max catch		20,000		
Forecast uncertainty	var	corr		
age 3	0.5	-0.5		
age 4	0.4			
age 5	1.2			
Implementation uncertainty				
CV	0.5			
Bias	1			
Fishery allocation				
ocean troll	0.3400			
ocean recreational	0.0850			
river tribal	0.5000			
river recreational	0.0750			
Ocean troll	vulner	legal	C&R	
age 3	0.25	0.80	0.26	
age 4	1.00	0.95	0.26	
age 5	2.00	1.00	0.26	
dropoff mort rate				0.05
Ocean recreational	vulner	legal	C&R	
age 3	0.50	0.99	0.14	
age 4	1.00	1	0.14	
age 5	2.00	1	0.14	
dropoff mort rate				0.05
RiverTribal	vulner	retain	C&R	
age 3	0.50	1	0	
age 4	1.00	1	0	
age 5	1.60	1	0	
dropoff mort rate				0.08
River recreational	vulner	retain	C&R	
age 3	1.40	1	0	
age 4	1	1	0	
age 5	0.95	1	0	
dropoff mort rate				0.02

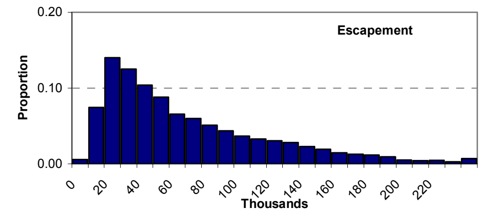
Run

Reset

Model Outputs







	1-5 yrs avg	*cv*	*min*	*max*	*> 5 yrs avg*	*cv*	*min*	*max*	*1-40 yr (avg) all*	*demin*
Numbers (H+W)										
Ocean	399,827	0.85	19,186	1,569,080	529,105	0.66	19,477	1,682,953	512,946	166,535
River	119,499	0.78	7,903	496,484	159,199	0.62	6,870	486,879	154,237	57,952
Spawn naturally	55,897	0.84	5,807	262,561	73,694	0.69	3,410	325,750	71,470	40,627
Hatchery rack	27,796		1,339	257,407	29,391		744	228,167	29,192	16,458
% hatchery					29%				29%	
Harvest (H+W)										
Ocean troll	15,972	1.26	0	121,811	25,790	0.91	0	150,385	24,563	2,759
Ocean sport	5,700	1.23	0	46,106	8,898	0.90	0	53,484	8,498	913
subtotal	*21,672*				*34,689*				*33,061*	*3,672*
River tribal	33,219	1.16	225	226,764	51,023	0.82	312	245,120	48,798	2,764
River sport	8,376	0.97	95	20,000	12,610	0.60	64	20,000	12,081	706
subtotal	*41,595*				*63,633*				*60,878*	*3,470*
	63,267				98,322				93,940	7,142
Fishery rates										
Harvest rate	0.140	--	0.009	0.538	0.184	--	0.007	0.559	0.178	0.051
Impact rate	0.150	--	0.010	0.573	0.197	--	0.007	0.596	0.191	0.054
Age 4 ocn imp	0.118	--	0.000	0.400	0.150	--	0.000	0.493	0.146	0.050
Spnr Reduc rate	0.566	--	0.273	0.901	0.644	--	0.248	0.904	0.634	0.390
Tribal harv share	0.500	--	0.120	0.858	0.498	--	0.115	0.887	0.499	0.431

Escapement

Frequencies	1-5yrs	6-40 yrs	1-40 yrs
yrs(E < 35,000)	0.485	0.255	0.284
yrs(E < 21.000)	0.148	0.085	0.093
yrs(E < 12,000)	0.023	0.013	0.014
iter(3yrs <35,000)	--	--	0.740
freq (2yrs<35000)	2.09	4.56	6.6
freq (3yrs<35000)	1.02	2.63	3.6
yrs(E trib <720)	0.248	0.147	0.159

Fishery

Frequencies	1-5yrs	6-40 yrs	1-40 yrs
yrs(de min fishery)	0.331	0.122	0.148
yrs(ocn 4 IR > 0.17)	0.260	0.406	0.388
yrs(ocn 4 IR <= 0.05	0.238	0.143	0.155
yrs(egg take goal)	0.774	0.692	0.702
yrs(0%< rt<50%)	0.492	0.492	0.492
freq(OverfishEvent)			2.4

Sub-Appendix Table G(c)-10. Fish management plan with 16% limit on ocean harvest rate (17% impact rate) and 10% *de minimis* fishing rate.

Model Inputs

Population

Iterations	200	
print all (0= no, 1 = yes)	1	
Initial population size (spnrs)		
2 years ago	24,100	
1 year ago	27,300	
Yr 1 ocean recruits	total #	p Hatch
age 3	44,100	0.67
age 4	63,700	0.55
age 5	2,200	0.72
Stock Recruitment Function		
alpha	14.87	
beta	1.787E-05	
spawners @ max constraint	162,000	
max recruits constraint	777,000	
Depensation (0=no, 1=yes)	1	
theshold escapement	35000	
Recr variation (ocean)	2	
0 = deterministic		
1 = random (log) normal	MSE :	0.91
2 = random autocorrelated	coef:	0.5
Freshwater production trend	0	
Age-specific maturity rate		
Age 3	0.379	
Age 4	0.883	
Age 5	1.000	
Ocean winter survival rate		
age 3	0.58	
age 4	0.8	
age 5	0.8	
Hatchery fish		
Annual releases (millions)	8.9	
SAR	0.007	
p natural spawning	0.1	
egg take goal (millions)	16	
eggs/spawner	1,250	

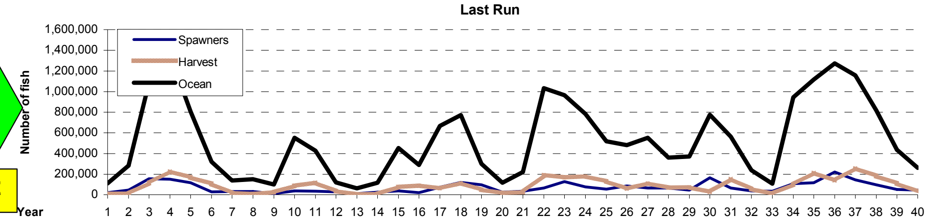
Fishery

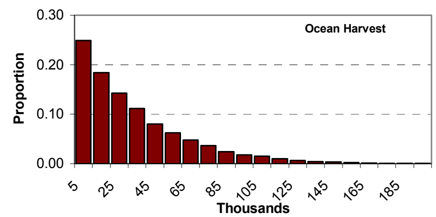
Fishing strategy	3	ref rate	ref esc	other
1 = fixed rate		0.000		
2 = Fish Management Plan		0.67	35000	
3 = de min (fixed)		0.1		
Rebuilding? (0 or 1)	0			
ESA Limit? (0 or 1)	1			
max impact		0.17		
transfer harv?		1		
River sport limitations				
max harv rate		0.12		
max catch		20,000		
Forecast uncertainty	var	corr		
age 3	0.5	-0.5		
age 4	0.4			
age 5	1.2			
Implementation uncertainty				
CV	0.5			
Bias	1			
Fishery allocation				
ocean troll	0.3400			
ocean recreational	0.0850			
river tribal	0.5000			
river recreational	0.0750			
Ocean troll	**vulner**	**legal**	**C&R**	
age 3	0.25	0.80	0.26	
age 4	1.00	0.95	0.26	
age 5	2.00	1.00	0.26	
dropoff mort rate				0.05
Ocean recreational	**vulner**	**legal**	**C&R**	
age 3	0.50	0.99	0.14	
age 4	1.00	1	0.14	
age 5	2.00	1	0.14	
dropoff mort rate				0.05
RiverTribal	**vulner**	**retain**	**C&R**	
age 3	0.50	1	0	
age 4	1.00	1	0	
age 5	1.60	1	0	
dropoff mort rate				0.08
River recreational	**vulner**	**retain**	**C&R**	
age 3	1.40	1	0	
age 4	1	1	0	
age 5	0.95	1	0	
dropoff mort rate				0.02

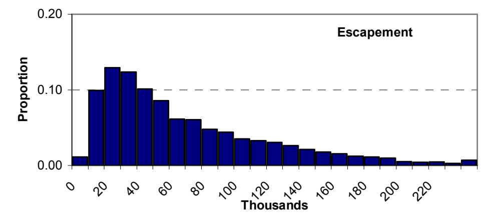
Run

Reset

Model Outputs







	1-5 yrs				> 5 yrs				1-40 yr (avg)	
	avg	*cv*	*min*	*max*	*avg*	*cv*	*min*	*max*	*all*	*demin*
Numbers (H+W)										
Ocean	390,658	0.87	17,287	1,635,363	524,452	0.66	17,745	1,682,953	507,728	180,480
River	115,813	0.80	6,463	510,185	157,335	0.63	5,811	486,763	152,144	59,539
Spawn naturally	52,916	0.88	4,146	262,384	72,263	0.71	2,328	325,745	69,845	38,691
Hatchery rack	27,733		1,239	257,439	29,328		682	294,549	29,129	16,576
% hatchery					29%				29%	
Harvest (H+W)										
Ocean troll	16,449	1.18	0	123,659	25,933	0.89	0	150,392	24,748	5,972
Ocean sport	5,842	1.16	0	47,192	8,945	0.88	0	53,691	8,557	1,978
subtotal	*22,291*				*34,878*				*33,305*	*7,950*
River tribal	33,321	1.11	424	228,589	50,770	0.81	547	241,564	48,589	6,277
River sport	8,366	0.94	185	20,000	12,591	0.59	110	20,000	12,063	1,551
subtotal	*41,688*				*63,360*				*60,651*	*7,829*
	63,979				98,239				93,956	15,779
Fishery rates										
Harvest rate	0.160	--	0.018	0.544	0.190	--	0.014	0.559	0.186	0.104
Impact rate	0.172	--	0.020	0.579	0.203	--	0.014	0.596	0.199	0.111
Age 4 ocn imp	0.135	--	0.000	0.400	0.157	--	0.000	0.493	0.154	0.100
Spnr Reduc rate	0.597	--	0.306	0.903	0.654	--	0.270	0.906	0.647	0.478
Tribal harv share	0.498	--	0.118	0.856	0.498	--	0.115	0.887	0.498	0.441

Escapement			
Frequencies	**1-5yrs**	**6-40 yrs**	**1-40 yrs**
yrs(E < 35,000)	0.518	0.274	0.305
yrs(E < 21.000)	0.289	0.101	0.125
yrs(E < 12,000)	0.029	0.019	0.021
iter(3yrs <35,000)	--	--	0.785
freq (2yrs<35000)	2.24	5.29	7.5
freq (3yrs<35000)	1.14	3.28	4.4
yrs(E trib <720)	0.292	0.160	0.177

Fishery			
Frequencies	**1-5yrs**	**6-40 yrs**	**1-40 yrs**
yrs(de min fishery)	0.425	0.167	0.199
yrs(ocn 4 IR > 0.17)	0.284	0.416	0.400
yrs(ocn 4 IR <= 0.05	0.117	0.096	0.098
yrs(egg take goal)	0.767	0.688	0.698
yrs(0%< rt<50%)	0.499	0.494	0.495
freq(OverfishEvent)			2.6

Sub-Appendix Table G(c)-11. Fish management plan with 16% limit on ocean harvest rate (17% impact rate) and 13% *de minimis* fishing rate.

Model Inputs

Population

Iterations	200	
print all (0= no, 1 = yes)	1	
Initial population size (spnrs)		
2 years ago	24,100	
1 year ago	27,300	
Yr 1 ocean recruits	total #	p Hatch
age 3	44,100	0.67
age 4	63,700	0.55
age 5	2,200	0.72
Stock Recruitment Function		
alpha	14.87	
beta	1.787E-05	
spawners @ max constraint	162,000	
max recruits constraint	777,000	
Depensation (0=no, 1=yes)	1	
theshold escapement	35000	
Recr variation (ocean)	2	
0 = deterministic		
1 = random (log) normal	MSE :	0.91
2 = random autocorrelated	coef:	0.5
Freshwater production trend	0	
Age-specific maturity rate		
Age 3	0.379	
Age 4	0.883	
Age 5	1.000	
Ocean winter survival rate		
age 3	0.58	
age 4	0.8	
age 5	0.8	
Hatchery fish		
Annual releases (millions)	8.9	
SAR	0.007	
p natural spawning	0.1	
egg take goal (millions)	16	
eggs/spawner	1,250	

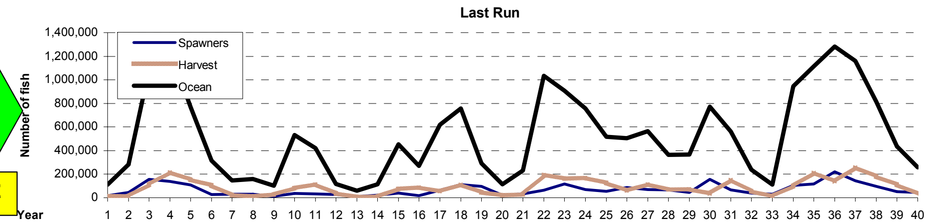
Fishery

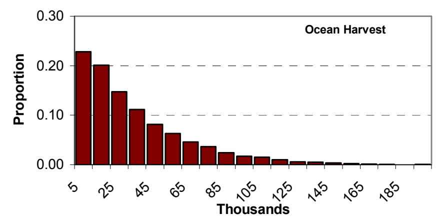
Fishing strategy	3	ref rate	ref esc	other
1 = fixed rate		0.000		
2 = Fish Management Plan		0.67	35000	
3 = de min (fixed)		0.13		
Rebuilding? (0 or 1)	0			
ESA Limit? (0 or 1)	1			
max impact		0.17		
transfer harv?		1		
River sport limitations				
max harv rate		0.12		
max catch		20,000		
Forecast uncertainty	var	corr		
age 3	0.5	-0.5		
age 4	0.4			
age 5	1.2			
Implementation uncertainty				
CV	0.5			
Bias	1			
Fishery allocation				
ocean troll	0.3400			
ocean recreational	0.0850			
river tribal	0.5000			
river recreational	0.0750			
Ocean troll	vulner	legal	C&R	
age 3	0.25	0.80	0.26	
age 4	1.00	0.95	0.26	
age 5	2.00	1.00	0.26	
dropoff mort rate				0.05
Ocean recreational	vulner	legal	C&R	
age 3	0.50	0.99	0.14	
age 4	1.00	1	0.14	
age 5	2.00	1	0.14	
dropoff mort rate				0.05
RiverTribal	vulner	retain	C&R	
age 3	0.50	1	0	
age 4	1.00	1	0	
age 5	1.60	1	0	
dropoff mort rate				0.08
River recreational	vulner	retain	C&R	
age 3	1.40	1	0	
age 4	1	1	0	
age 5	0.95	1	0	
dropoff mort rate				0.02

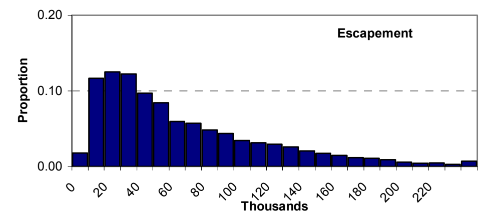
Run

Reset

Model Outputs







	1-5 yrs				> 5 yrs				1-40 yr (avg)	
	avg	*cv*	*min*	*max*	*avg*	*cv*	*min*	*max*	*all*	*demin*
Numbers (H+W)										
Ocean	382,918	0.88	16,016	1,814,616	519,986	0.67	16,765	1,614,556	502,852	193,605
River	112,755	0.82	5,607	575,143	155,603	0.64	5,291	486,708	150,247	61,497
Spawn naturally	50,408	0.91	3,193	395,243	70,996	0.73	1,851	325,970	68,423	37,996
Hatchery rack	27,781		1,175	257,436	29,277		642	295,934	29,090	17,182
% hatchery					29%				30%	
Harvest (H+W)										
Ocean troll	16,788	1.12	0	127,502	26,027	0.88	0	150,381	24,872	8,274
Ocean sport	5,942	1.11	0	49,450	8,976	0.87	0	53,820	8,597	2,754
subtotal	*22,730*				*35,003*				*33,469*	*11,028*
River tribal	33,295	1.07	531	233,096	50,458	0.80	588	236,689	48,313	8,584
River sport	8,330	0.92	237	20,000	12,565	0.58	131	20,000	12,036	2,158
subtotal	*41,626*				*63,023*				*60,348*	*10,743*
	64,356				98,026				93,817	21,771
Fishery rates										
Harvest rate	0.175	--	0.024	0.560	0.194	--	0.016	0.558	0.192	0.134
Impact rate	0.188	--	0.026	0.596	0.208	--	0.016	0.595	0.205	0.144
Age 4 ocn imp	0.147	--	0.000	0.400	0.162	--	0.000	0.493	0.160	0.130
Spnr Reduc rate	0.620	--	0.326	0.908	0.661	--	0.284	0.907	0.656	0.530
Tribal harv share	0.496	--	0.116	0.856	0.496	--	0.112	0.887	0.496	0.440

Escapement

Frequencies	1-5yrs	6-40 yrs	1-40 yrs
yrs(E < 35,000)	0.534	0.289	0.320
yrs(E < 21.000)	0.345	0.120	0.148
yrs(E < 12,000)	0.064	0.026	0.031
iter(3yrs <35,000)	--	--	0.815
freq (2yrs<35000)	2.33	5.87	8.2
freq (3yrs<35000)	1.22	3.77	5.0
yrs(E trib <720)	0.330	0.173	0.193

Fishery

Frequencies	1-5yrs	6-40 yrs	1-40 yrs
yrs(de min fishery)	0.462	0.205	0.237
yrs(ocn 4 IR > 0.17)	0.356	0.448	0.437
yrs(ocn 4 IR <= 0.05	0.091	0.086	0.087
yrs(egg take goal)	0.710	0.685	0.689
yrs(0%< rt<50%)	0.503	0.499	0.499
freq(OverfishEvent)			2.9

Sub-Appendix Table G(c)-12. Fish management plan with fixed ocean impact rate selected to provide an 80% probability of natural spawning escapements of at least 35,000.

Model Inputs

Population

Iterations	200	
print all (0= no, 1 = yes)	1	
Initial population size (spnrs)		
2 years ago	24,100	
1 year ago	27,300	
Yr 1 ocean recruits	total #	p Hatch
age 3	44,100	0.67
age 4	63,700	0.55
age 5	2,200	0.72
Stock Recruitment Function		
alpha	14.87	
beta	1.787E-05	
spawners @ max constraint	162,000	
max recruits constraint	777,000	
Depensation (0=no, 1=yes)	1	
theshold escapement	35000	
Recr variation (ocean)	2	
0 = deterministic		
1 = random (log) normal	MSE :	0.91
2 = random autocorrelated	coef:	0.5
Freshwater production trend	0	
Age-specific maturity rate		
Age 3	0.379	
Age 4	0.883	
Age 5	1.000	
Ocean winter survival rate		
age 3	0.58	
age 4	0.8	
age 5	0.8	
Hatchery fish		
Annual releases (millions)	8.9	
SAR	0.007	
p natural spawning	0.1	
egg take goal (millions)	16	
eggs/spawner	1,250	

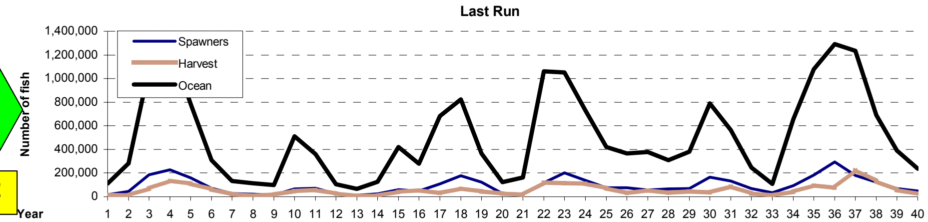
Fishery

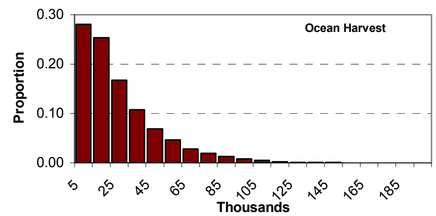
Fishing strategy	1	ref rate	ref esc	other
1 = fixed rate		0.123		
2 = Fish Management Plan		0.67	35000	
3 = de min (fixed)				
Rebuilding? (0 or 1)	0			
ESA Limit? (0 or 1)	1			
max impact		0.17		
transfer harv?		1		
River sport limitations				
max harv rate		0.12		
max catch		20,000		
Forecast uncertainty	var	corr		
age 3	0.5	-0.5		
age 4	0.4			
age 5	1.2			
Implementation uncertainty				
CV	0.5			
Bias	1			
Fishery allocation				
ocean troll	0.3400			
ocean recreational	0.0850			
river tribal	0.5000			
river recreational	0.0750			
Ocean troll	vulner	legal	C&R	
age 3	0.25	0.80	0.26	
age 4	1.00	0.95	0.26	
age 5	2.00	1.00	0.26	
dropoff mort rate				0.05
Ocean recreational	vulner	legal	C&R	
age 3	0.50	0.99	0.14	
age 4	1.00	1	0.14	
age 5	2.00	1	0.14	
dropoff mort rate				0.05
RiverTribal	vulner	retain	C&R	
age 3	0.50	1	0	
age 4	1.00	1	0	
age 5	1.60	1	0	
dropoff mort rate				0.08
River recreational	vulner	retain	C&R	
age 3	1.40	1	0	
age 4	1	1	0	
age 5	0.95	1	0	
dropoff mort rate				0.02

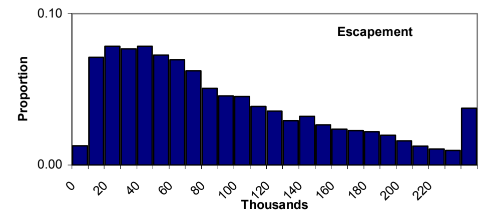
Run

Reset

Model Outputs







	1-5 yrs				> 5 yrs				1-40 yr (avg)	
	avg	*cv*	*min*	*max*	*avg*	*cv*	*min*	*max*	*all*	*demin*
Numbers (H+W)										
Ocean	387,099	0.87	16,319	1,741,003	511,126	0.68	18,336	1,575,276	495,622	0
River	118,221	0.83	5,805	578,343	160,650	0.65	5,248	514,739	155,346	0
Spawn naturally	68,695	0.91	3,404	366,970	97,771	0.68	1,834	356,639	94,137	0
Hatchery rack	35,527		1,190	314,656	39,553		650	217,294	39,050	0
% hatchery					29%				29%	
Harvest (H+W)										
Ocean troll	13,168	1.04	0	93,451	19,192	0.85	0	118,929	18,439	0
Ocean sport	4,626	1.03	0	35,802	6,574	0.85	0	42,411	6,331	0
subtotal	*17,794*				*25,766*				*24,770*	*0*
River tribal	21,342	0.93	506	146,078	30,770	0.78	591	171,802	29,592	0
River sport	3,282	0.85	225	18,957	4,705	0.68	124	20,000	4,527	0
subtotal	*24,624*				*35,475*				*34,119*	*0*
	42,418				61,241				58,889	0
Fishery rates										
Harvest rate	0.131	--	0.023	0.434	0.130	--	0.016	0.441	0.130	0.000
Impact rate	0.141	--	0.024	0.464	0.140	--	0.017	0.471	0.140	0.000
Age 4 ocn imp	0.121	--	0.000	0.322	0.124	--	0.000	0.357	0.124	0.000
Spnr Reduc rate	0.535	--	0.322	0.852	0.541	--	0.293	0.832	0.540	0.000
Tribal harv share	0.501	--	0.116	0.915	0.500	--	0.116	0.904	0.500	0.000

Escapement			
Frequencies	**1-5yrs**	**6-40 yrs**	**1-40 yrs**
yrs(E < 35,000)	0.424	0.167	0.199
yrs(E < 21.000)	0.283	0.066	0.093
yrs(E < 12,000)	0.045	0.019	0.022
iter(3yrs <35,000)	--	--	0.615
freq (2yrs<35000)	1.91	3.11	5.0
freq (3yrs<35000)	0.84	1.69	2.5
yrs(E trib <720)	0.265	0.108	0.128

Fishery			
Frequencies	**1-5yrs**	**6-40 yrs**	**1-40 yrs**
yrs(de min fishery)	0.000	0.000	0.000
yrs(ocn 4 IR > 0.17)	0.210	0.225	0.223
yrs(ocn 4 IR <= 0.05	0.117	0.119	0.119
yrs(egg take goal)	0.788	0.797	0.796
yrs(0%< rt<50%)	0.492	0.495	0.495
freq(OverfishEvent)			1.9

Sub-Appendix D. Measurement Error Data

Sub-Appendix Table G (d)-13. Pre- and post-season comparisons of age-3 and age-4 ocean abundance estimates, 1988-2005

	Age-3		Age-4		Age-3	Age-4
Season	Pre	Post	Pre	Post	Pre/post	Pre/post
1988	370800	758625	186375	236159	0.489	0.789
1989	450600	367979	215500	178110	1.225	1.210
1990	479000	176803	50125	103324	2.709	0.485
1991	176200	69609	44625	37308	2.531	1.196
1992	50000	39637	44750	28261	1.261	1.583
1993	294400	168858	39125	15091	1.743	2.593
1994	138000	120329	86125	41821	1.147	2.059
1995	269000	784221	47000	28827	0.343	1.630
1996	479800	190977	268500	225886	2.512	1.189
1997	224600	140784	53875	63019	1.595	0.855
1998	176000	154679	46000	45039	1.138	1.021
1999	84800	129696	78750	30259	0.654	2.603
2000	349600	618688	38875	44462	0.565	0.874
2001	187200	358169	247000	134245	0.523	1.840
2002	209000	565734	143800	99993	0.369	1.438
2003	171300	540668	132400	220224	0.317	0.601
2004	72100	159242	134500	166527	0.453	0.808
2005	185700	209493	48900	34791	0.886	1.406
mean=	**242672**	**308566**	**105901**	**96297**	**1.137**	**1.343**
G. mean=					**0.899**	**1.214**
variance=	**2.E+10**	**6.E+10**	**6.E+09**	**6.E+09**	**0.629**	**0.386**
SE=	**31848**	**56663**	**18212**	**18224**	**0.187**	**0.146**
SD=	**135119**	**240401**	**77266**	**77319**	**0.793**	**0.621**
CV=	**0.557**	**0.779**	**0.730**	**0.803**	**0.698**	**0.463**
median=	**198100**	**183890**	**66313**	**54029**	**1.137**	**1.277**

Sub Appendix Table G(d)-14. Pre- and post-season comparisons or age-3 and age-4 maturity rate estimates, 1988-2005

	Pre-season		Post-season		Pre/post	
Season	Age-3	Age-4	Age-3	Age-4	age-3	age-4
1988	0.430	0.890	0.365	0.901	1.178	0.988
1989	0.430	0.890	0.330	0.901	1.303	0.988
1990	0.430	0.890	0.238	0.893	1.807	0.997
1991	0.430	0.890	0.265	0.937	1.623	0.950
1992	0.370	0.940	0.320	0.914	1.156	1.028
1993	0.370	0.940	0.550	0.853	0.673	1.102
1994	0.340	0.950	0.567	0.873	0.600	1.088

1995	0.340	0.940	0.463	0.957	0.734	0.982
1996	0.360	0.940	0.107	0.939	3.364	1.001
1997	0.370	0.940	0.439	0.949	0.843	0.991
1998	0.380	0.930	0.662	0.934	0.574	0.996
1999	0.378	0.936	0.398	0.960	0.950	0.975
2000	0.382	0.937	0.583	0.992	0.655	0.945
2001	0.399	0.939	0.499	0.927	0.800	1.013
mean	**0.386**	**0.925**	**0.413**	**0.924**	**1.161**	**1.003**
G. mean=					**1.016**	**1.002**
variance=	**0.001**	**0.001**	**0.024**	**0.001**	**0.548**	**0.002**
SE	**0.009**	**0.006**	**0.041**	**0.010**	**0.198**	**0.012**
SD=	**0.032**	**0.023**	**0.154**	**0.037**	**0.740**	**0.045**
CV=	**0.084**	**0.025**	**0.373**	**0.040**	**0.637**	**0.045**
median=	**0.379**	**0.938**	**0.419**	**0.931**	**0.896**	**0.993**

Sub-Appendix Table G(d)-15. Pre- and post-season comparisons of proportions spawning in natural areas, 1998-2005

Season	Pre	Post	Pre/post
1988	0.780	0.704	1.109
1989	0.780	0.666	1.171
1990	0.740	0.659	1.123
1991	0.740	0.642	1.152
1992	0.740	0.620	1.193
1993	0.740	0.502	1.473
1994	0.520	0.654	0.795
1995	0.620	0.810	0.765
1996	0.660	0.802	0.823
1997	0.690	0.712	0.969
1998	0.710	0.593	1.198
1999	0.710	0.563	1.261
2000	0.700	0.459	1.526
2001	0.630	0.585	1.076
2002	0.614	0.707	0.868
2003	0.610	0.587	1.040
2004	0.600	0.509	1.179
2005	0.548	0.496	1.104
mean	**0.674**	**0.626**	**1.101**
G. mean=			**1.083**
variance=	**0.006**	**0.010**	**0.043**
SE	**0.018**	**0.024**	**0.049**
SD=	**0.077**	**0.100**	**0.208**
CV=	**0.114**	**0.160**	**0.189**
median=	**0.695**	**0.631**	**1.116**

Sub-Appendix Table G(d)-16. Pre- and post-season comparisons of natural spawning population estimates, 1988-2005

Season	Goal	Post	Pre/Post
1988	66.5	79.4	0.838
1989	78.0	43.9	1.778
1990	49.6	15.6	3.180
1991	35.0	11.6	3.005
1992	27.0	12.0	2.245
1993	38.0	21.9	1.738
1994	35.1	32.3	1.086
1995	35.0	161.8	0.216
1996	66.5	81.3	0.818
1997	35.3	46.1	0.765
1998	35.0	42.5	0.824
1999	35.5	18.5	1.923
2000	35.0	82.7	0.423
2001	47.0	77.8	0.604
2002	35.0	65.6	0.533
2003	35.0	87.6	0.399
2004	35.0	23.8	1.469
2005	35.0	27.3	1.282
mean=	**42.1**	**51.8**	**1.285**
G. mean=			**1.016**
variance=	**196.9**	**1488.1**	**0.765**
SE	**3.3**	**9.1**	**0.206**
SD=	**14.0**	**38.6**	**0.874**
CV=	**0.3**	**0.7**	**0.681**
median=	**35.1**	**43.2**	**0.962**

Sub-Appendix E – Model Source Code

Available from the Council upon request.

APPENDIX H: FORMULA USED TO ESTIMATE LONG-TERM LANDED CATCH, DATA ON EFFECT OF EX-VESSEL PRICE ON TROLL FISHERY REVENUES AND LONG-TERM IMPACT OF THE ALTERNATIVES ON RIVER RECREATIONAL SALMON FISHERY EXPENDITURES

Long-term catch formula for troll fishery analyses

The SSRM model was used to estimate long-term (40-yr time frame) average annual landed catch for each *de minimis* fishing alternative, as follows:

$LC_{i,\,s} = \sum (P_{r,\,i,\,s} * C_{r,\,i.\,s})$
and
$C_{r,\,i,\,s} + V_{i,\,a} * CE_{a,\,s}$

where:

$LC_{i,s}$=average annual landed catch for a de minimis alternative over a 40 year time frame
$P_{r,i,s}$=proportion of the 40 year time period in six ocean impact rate categories
$C_{r,i,s}$=landed catch at ocean impact rate category (0.0%, 2.5%, 5%, 10%, 16%, 16% OHR)
$V_{i,a}$=vessel-days by area from KOHM at ocean impact rate category
$CE_{a,s}$=average catch per vessel-day by ocean troll area

r=ocean impact rate category
- 1=0-2%
- 2=3-4%
- 3=5-8%
- 4=9-12%
- 5=13-16%
- 6=>16%

i=de minimis alternatives
s=low, medium, high fishing success

Data on ex-vessel price effects on Troll Fishery Revenues

Since price along with landings determines revenue and price is hard to predict because many factors determine price, such as local supply and demand, import supply and demand, and input prices to name a few, four different price constraints were used to show possible ex-vessel revenues.

Year 2005 average prices by State is the first price constraint used. Oregon tracks historical prices by salmon size. Oregon's average price per pound for salmon greater than 11 pounds was used, because the average size of salmon caught in the past five years is about 12 pounds. There are also revenue projections based on $6.00 per pound because this is about the average price fishermen obtained in the first half of 2006's season (calculated from preliminary data). Since year 2006 had extremely restricted management measures for commercial fishermen and therefore salmon supply is very low from OR (South of Cape Falcon) and CA fishermen, $6.00 per pound may represent a de minimis year's price.
Table 4-11-2 shows revenue estimates based on historical (1991-2005) prices for the low and high years by State. Oregon's lowest price per pound was in 2002 at $1.66 and the high was in 2004 at $3.54. California's lowest price per pound was in 1997 at $1.62 and the high was in 1992 at $3.55.

Table H-1: Estimated Oregon and California troll fishery revenues ($ 000s) under the Council's *de minimis* fishery alternatives in a hypothetical Conservation Alert year for KRFC based on three levels of troll fishery success rate and using low and high ex-vessel prices.

	Revenue based on low year price per pound ($1.66 for OR & $1.62 for CA)				Revenue Based on high year price per pound ($3.28 for OR and $3.55 for CA)			
AREA and Relative Success Rate 1/	Status quo 2/	5%	10%	13%	Status quo 2/	5%	10%	13%
OREGON:								
Tillamook-Newport								
low	$0	$546	$550	$633	$0	$1,078	$1,087	$1,250
medium	$0	$1,136	$1,145	$1,317	$0	$2,244	$2,262	$2,602
high	$0	$1,845	$1,860	$2,140	$0	$3,646	$3,676	$4,228
Coos Bay								
low	$0	$47	$102	$130	$0	$92	$201	$257
medium	$0	$128	$278	$355	$0	$252	$550	$702
high	$0	$185	$403	$516	$0	$366	$797	$1,019
OR TOTAL								
low	$0	$592	$652	$763	$0	$1,171	$1,288	$1,507
medium	$0	$1,263	$1,423	$1,672	$0	$2,496	$2,811	$3,304
high	$0	$2,030	$2,264	$2,655	$0	$4,012	$4,473	$5,246
Historical Range from 1990-2005: $857- $1,189 (Note: Includes Astoria)								
CALIFORNIA:								
San Francisco								
low	$0	$521	$521	$521	$0	$1,143	$1,143	$1,143
medium	$0	$816	$816	$816	$0	$1,788	$1,788	$1,788
high	$0	$1,303	$1,303	$1,303	$0	$2,855	$2,855	$2,855
Monterey								
low	$0	$304	$1,161	$1,415	$0	$665	$2,545	$3,101
medium	$0	$554	$2,119	$2,582	$0	$1,214	$4,643	$5,659
high	$0	$952	$3,640	$4,436	$0	$2,086	$7,977	$9,721
CA TOTAL								
low	$0	$825	$1,683	$1,937	$0	$1,808	$3,687	$4,244
medium	$0	$1,370	$2,935	$3,398	$0	$3,002	$6,431	$7,446
high	$0	$2,255	$4,943	$5,739	$0	$4,941	$10,832	$12,576
Historical Range from 1990-2005: $3,555 - $18,383								
TOTAL								
low	$0	$1,418	$2,335	$2,699	$0	$2,979	$4,976	$5,751
medium	$0	$2,633	$4,358	$5,070	$0	$5,498	$9,243	$10,750
high	$0	$4,285	$7,207	$8,394	$0	$8,953	$15,305	$17,822

1/ Low, medium and high refer to years of low, medium and high troll fishery success rate during 1991-2004 measured as Chinook salmon catch per troll fishing day.
2/ Assumed to be a year when the projected natural escapement of KRFC is < 35,000 adult fish in the absence of fishing. The *de minimis* fishery thresholds vary between the alternatives, thus some level of fishing would be allowed when stock sizes were in

Comparing options and being conservative, let's assume, for example that there will be a low catch level. If so, and the west coast fishermen were obtaining year 2005 prices, the West Coast would earn approximately $735,000 at the 2.5% option, $1,935,000 at the 5% option, $4,330,000 at the 10% option and $6,080,000 at the 16% level.

Looking at how catch levels affect revenue, on average, the West Coast high catch level is about twice as large in revenue as the medium catch level and the medium catch level is about 1.5 times greater than the low catch level.

Comparing across options, in the Tillamook/Newport area, the 16% option produces about twice the revenue of the 10% option. The 10% option is about 2.5 times the revenue of the 5% option and the 5% option is about 3.5 times the revenue of the 2.5% option. In the Coos Bay area, the 16% option is about 2.5 times the revenue of the 10% option and there is no 5% or 2.5% option. In San Francisco, options 16%, 10% and 5% produce identical revenues and are all about double that of the 2.5% option. In Monterey, the 16% option is about 1.5 times that of the 10% option. The 10% option is about four times that of the 5% option and the 5% option is about 6 times that of the 2.5% option. This data shows that as the option levels increase, the revenues increases at a decreasing rate.

The following table shows the same affect as described above and is shown here to provide a range of total revenues that may be achieved from a de minimis fishing season. Note that due to a small catch in a de minimis year, it is more likely that prices would be closer to the historical high prices than low prices.

Table H-2: Estimated Oregon and California troll fishery revenues ($ 000s) under the Council's *de minimis* fishery alternatives in a hypothetical Conservation Alert year for KRFC based on three levels of troll fishery success rate and using 2005 and 2006 ex-vessel prices.

	Revenue based on 2005 per pound price ($3.10 for OR & $2.97 for CA)				Revenue based on 2001-2005 average per pound price ($2.442 for OR & $2.354 for CA)			
AREA and Relative Success Rate 1/	Status quo 2/	5%	10%	13%	Status quo 2/	5%	10%	13%
OREGON:								
Tillamook-Newport								
low	$0	$1,019	$1,027	$1,182	$0	$803	$809	$931
medium	$0	$2,121	$2,138	$2,459	$0	$1,671	$1,684	$1,937
high	$0	$3,446	$3,474	$3,996	$0	$2,715	$2,737	$3,148
Coos Bay								
low	$0	$87	$190	$243	$0	$69	$150	$191
medium	$0	$238	$519	$664	$0	$188	$409	$523
high	$0	$345	$753	$963	$0	$272	$594	$759
OR TOTAL								
low	$0	$1,106	$1,217	$1,425	$0	$871	$959	$1,122
medium	$0	$2,359	$2,657	$3,123	$0	$1,858	$2,093	$2,460
high	$0	$3,792	$4,228	$4,959	$0	$2,987	$3,330	$3,906
Historical Range from 1990-2005: $857 - $1,189 (Note: Includes Astoria)								
CALIFORNIA:								
San Francisco								
low	$0	$956	$956	$956	$0	$758	$758	$758
medium	$0	$1,496	$1,496	$1,496	$0	$1,185	$1,185	$1,185
high	$0	$2,389	$2,389	$2,389	$0	$1,893	$1,893	$1,893
Monterey								
low	$0	$557	$2,129	$2,594	$0	$441	$1,687	$2,056
medium	$0	$1,016	$3,885	$4,734	$0	$805	$3,079	$3,752
high	$0	$1,745	$6,673	$8,133	$0	$1,383	$5,289	$6,446
CA TOTAL								
low	$0	$1,513	$3,085	$3,551	$0	$1,199	$2,445	$2,814
medium	$0	$2,511	$5,380	$6,230	$0	$1,991	$4,264	$4,938
high	$0	$4,134	$9,062	$10,521	$0	$3,276	$7,182	$8,339
Historical Range from 1990-2005: $3,555- $18,383								
TOTAL								
low	$0	$2,619	$4,302	$4,975	$0	$2,070	$3,404	$3,936
medium	$0	$4,870	$8,038	$9,352	$0	$3,849	$6,358	$7,397
high	$0	$7,925	$13,290	$15,480	$0	$6,263	$10,513	$12,245

1/ Low, medium and high refer to years of low, medium and high troll fishery success rate during 1991-2004 measured as Chinook salmon catch per troll fishing day.
2/ Assumed to be a year when the projected natural escapement of KRFC is < 35,000 adult fish in the absence of fishing. The *de minimis* fishery thresholds vary between the alternatives, thus some level of fishing would be allowed when stock sizes were in

The following two tables show average revenue over a 40 year time period. There is an FMP option shown here, because over a 40 year time period, there would be de minimis and non-de minimis fishing seasons.

Table H-3: Projected long-term 3/ average annual Oregon and California troll fishery revenues ($ 000s) under the Council's *de minimis* fishery alternatives for KRFC based on three levels of troll fishery success rate and using low and high ex-vessel prices.

	Revenue based on low year price per pound ($1.66 for OR & $1.62 for CA)				Revenue Based on high year price per pound ($3.28 for OR and $3.55 for CA)			
AREA and Relative Success Rate 1/	Status quo 2/	5%	10%	13%	Status quo 2/	5%	10%	13%
OREGON:								
Tillamook-Newport								
low	$592	$708	$716	$761	$1,169	$1,399	$1,415	$1,504
medium	$1,231	$1,473	$1,490	$1,584	$2,433	$2,910	$2,945	$3,130
high	$2,001	$2,394	$2,422	$2,575	$3,954	$4,730	$4,785	$5,087
Coos Bay								
low	$142	$152	$172	$189	$280	$301	$340	$373
medium	$387	$415	$470	$516	$765	$821	$929	$1,020
high	$562	$603	$682	$749	$1,110	$1,191	$1,348	$1,479
OR TOTAL								
low	$733	$860	$888	$950	$1,449	$1,699	$1,755	$1,878
medium	$1,619	$1,888	$1,961	$2,100	$3,198	$3,731	$3,874	$4,150
high	$2,563	$2,996	$3,104	$3,323	$5,064	$5,920	$6,133	$6,566
Historical Range from 1990-2005: $857- $1,189 (Note: Includes Astoria)								
CALIFORNIA:								
San Francisco								
low	$415	$504	$505	$521	$910	$1,105	$1,108	$1,143
medium	$649	$789	$791	$816	$1,423	$1,728	$1,733	$1,788
high	$1,037	$1,259	$1,263	$1,303	$2,273	$2,760	$2,768	$2,855
Monterey								
low	$1,107	$1,048	$1,392	$1,575	$2,296	$2,425	$3,051	$3,452
medium	$2,019	$2,019	$2,540	$2,874	$4,189	$4,425	$5,567	$6,299
high	$3,469	$3,469	$4,364	$4,938	$7,197	$7,602	$9,564	$10,821
CA TOTAL								
low	$1,522	$1,552	$1,898	$2,097	$3,206	$3,530	$4,159	$4,595
medium	$2,669	$2,808	$3,331	$3,690	$5,612	$6,153	$7,300	$8,087
high	$4,506	$4,728	$5,627	$6,241	$9,470	$10,362	$12,331	$13,676
Historical Range from 1990-2005: $3,555- $18,383								
TOTAL								
low	$2,255	$2,412	$2,786	$3,047	$4,655	$5,229	$5,914	$6,472
medium	$4,287	$4,696	$5,292	$5,791	$8,811	$9,884	$11,174	$12,237
high	$7,069	$7,725	$8,731	$9,564	$14,533	$16,282	$18,465	$20,242

1/ Low, medium and high refer to years of low, medium and high troll fishery success rate during 1991-2004 measured as Chinook salmon catch per troll fishing day.
2/ Assumed to be a year when the projected natural escapement of KRFC is < 35,000 adult fish in the absence of fishing. T
3/ Based on the stock recruitment simulation model.

Table H-4: Projected long-term 3/ average annual Oregon and California troll fishery revenues ($ 000s) under the Council's de minimis fishery alternatives for KRFC based on three levels of troll fishery success rate and using 2005 and 2006 ex-vessel prices.

	Revenue based on 2005 per pound price ($3.10 for OR & $2.97 for CA)				Revenue based on 2001-2005 average per pound price ($2.442 for OR & $2.354 for CA)			
AREA and Relative Success Rate 1/	Status quo 2/	5%	10%	13%	Status quo 2/	5%	10%	13%
OREGON: Tillamook-Newport								
low	$1,105	$1,322	$1,337	$1,422	$870	$1,041	$1,054	$1,120
medium	$2,299	$2,751	$2,783	$2,959	$1,811	$2,167	$2,192	$2,331
high	$3,737	$4,470	$4,523	$4,808	$2,943	$3,521	$3,563	$3,787
Coos Bay								
low	$265	$284	$322	$353	$209	$224	$253	$278
medium	$723	$776	$878	$964	$570	$611	$692	$759
high	$1,049	$1,125	$1,274	$1,398	$826	$886	$1,004	$1,101
OR TOTAL								
low	$1,370	$1,606	$1,659	$1,775	$1,079	$1,265	$1,307	$1,398
medium	$3,023	$3,526	$3,661	$3,922	$2,381	$2,778	$2,884	$3,090
high	$4,786	$5,595	$5,797	$6,206	$3,770	$4,408	$4,566	$4,889
Historical Range from 1990-2005: $857- $1,189 (Note: Includes Astoria)								
CALIFORNIA: San Francisco								
low	$761	$924	$927	$956	$603	$732	$735	$758
medium	$1,191	$1,446	$1,450	$1,496	$944	$1,146	$1,149	$1,185
high	$1,901	$2,309	$2,315	$2,389	$1,507	$1,830	$1,835	$1,893
Monterey								
low	$1,921	$2,029	$2,552	$2,888	$1,522	$1,522	$2,023	$2,289
medium	$3,505	$3,702	$4,658	$5,270	$2,778	$2,934	$3,692	$4,177
high	$6,021	$6,360	$8,001	$9,053	$4,772	$5,041	$6,342	$7,175
CA TOTAL								
low	$2,682	$2,953	$3,479	$3,844	$2,126	$2,255	$2,758	$3,047
medium	$4,696	$5,148	$6,107	$6,765	$3,722	$4,080	$4,841	$5,362
high	$7,922	$8,669	$10,316	$11,441	$6,279	$6,871	$8,177	$9,068
Historical Range from 1990-2005: $3,555,000 - $18,383,000								
TOTAL								
low	$4,052	$4,559	$5,138	$5,619	$3,205	$3,520	$4,064	$4,445
medium	$7,718	$8,674	$9,769	$10,688	$6,103	$6,858	$7,725	$8,452
high	$12,708	$14,264	$16,113	$17,647	$10,049	$11,279	$12,743	$13,957

1/ Low, medium and high refer to years of low, medium and high troll fishery success rate during 1991-2004 measured as Chinook salmon catch per troll fishing day.
2/ This is a year when the projected natural escapement of KRFC is < 35,000 adult fish in the absence of fishing.

3/ Based on the stock recruitment simulation model.

Comparing options and being conservative again, let's assume, for example that there will be a low catch level. If so, and the west coast fishermen were obtaining year 2005 prices, the West Coast would earn approximately $5,257,000 under the FMP Option, $5,202,000 for the sliding scale option, $5,442,000 at the 5% option, $5,442,000 at the 10% option and $5,954,000 at the 16% option.
Looking at catch levels, on average, the West Coast high catch level is about twice as large in revenue as the medium catch level and the medium catch level is about 1.5 times greater than the low catch level.

Comparing across options and looking at the differences between the FMP Option compared to the 16% Option, which would be the maximum difference in revenue across all options, in the Tillamook/Newport area, $124,141 is the difference between revenue at the low catch level, $258,332 at the medium catch level and $419,802 at the high catch level. In the Coos Bay area, $20,757 is the difference at the low catch level, $56,692 at the medium catch level and $82,244 at the high catch level.
In San Francisco, $63,933 is the difference at the low catch level, $100,019 at the medium level, $159,730 at the high level. In Monterey, $223,137 is the difference at the low catch level, $407,157 at the medium level and $699,451 at the high level.

Therefore the difference of revenue between options increases at the catch level increases. Monterey produces the largest revenue difference of $699,451 assuming a high catch level.

Table H-5: Projected long-term average annual river recreational fishery expenditures ($ 000s) .

Alternative	SSRM Years	Harvest	Trips	Expenditures
SQ	< 5	8,331	38854	$2,590
	yr 5-40	12,605	42031	$2,802
	yr 1-40	12,071	41736	$2,783
5%	< 5	8,376	38900	$2,593
	yr 5-40	12,610	42033	$2,802
	yr 1-40	12,081	41742	$2,783
10%	< 5	8,366	38890	$2,593
	yr 5-40	12,591	42023	$2,802
	yr 1-40	12,063	41732	$2,782
13%	< 5	8,330	38853	$2,590
	yr 5-40	12,565	42009	$2,801
	yr 1-40	12,036	41716	$2,781

APPENDIX I: SUPPLEMENTAL ECONOMIC ANALYSIS OF COMMUNITY AND FISHERY ABILITIES TO ADAPT TO ALTERNATIVES

I. Introduction

The economic analysis provided in Appendix J discusses differences among the de minimis alternatives (status quo, 5%, 10%, 13%) in terms of aggregate salmon troll revenues and associated income impacts. That analysis indicated little difference among the alternatives in terms of long-term economic effects, largely due to the relative infrequency of Conservation Alert years over the 40-year projection period. The alternatives, however, indicated more substantial differences when the analysis focused on fishery outcomes in Conservation Alert years.

This analysis supplements the results of Appendix J by demonstrating potential effects of the alternatives on fishing communities and the salmon troll fleet in terms of their ability to adapt to the restrictions imposed in Conservation Alert years. The indicators of adaptability used here pertain to community and vessel dependence on the salmon fishery and the extent to which other fisheries are viable alternative sources of revenue.[8]

II. Fishing Communities

The fishing communities considered in this analysis include the 16 ports in the Klamath management areas for which the annual ex-vessel value of salmon troll landings averaged at least $100,000 during 2003-2005 (see Figure K-1). Table K-1 characterizes port dependence on salmon in terms of the percentage of total landings and revenues attributable to salmon, and the percentage of vessels based in the port who participate in the salmon troll fishery.[9] Port dependence (as reflected in the percentage of total port revenue attributable to salmon) was highest for Santa Cruz, Bodega Bay, Fort Bragg, Princeton and San Francisco. Ports with the highest absolute salmon revenues included Fort Bragg, Newport, Coos Bay, San Francisco, Bodega Bay and Princeton.

Table K-2 augments the salmon revenue information in Table K-1 by identifying, for each port, all non-salmon fisheries that accounted for at least 5% of of the average annual ex-vessel value of landings during 2003-2005. Average ex-vessel values during 1994-2005 are also provided. For some fisheries (e.g, non-whiting groundfish trawl, which will likely continue to be restricted as it has in recent years), the 2003-2005 values are probably more reflective of future revenues than the 1994-2005 values. For other fisheries (e.g., squid seine, which experiences high inter-annual variability in landings), the 1994-2005 values may be the more appropriate indicator of future revenues. For yet other fisheries (e.g., salmon troll, crab pot), it is not clear which of the average revenue estimates is more appropriate, as these fisheries have experienced unusually high revenues in recent years which may or may not be sustainable over the long term (see Figure K-2).

Table K-3 predicts what salmon troll landings would be in each port in a Conservation Alert

[8] William Daspit and Brad Stenberg (Pacific States Marine Fisheries Commission, PacFIN Program) provided and facilitated interpretation of the data used in this analysis.

[9] To avoid double counting of vessels that land fish in multiple ports, each vessel was assigned to the port that accounted for the plurality of its revenue from all fisheries.

year under each of the de minimis alternatives - based on the assumed season structure scenarios described in Table 4-15 of this EA. Specifically, the projections were made by converting the low, medium and high CPUE revenue estimates contained in Table J-1 to pounds, then allocating the resulting poundage among the ports within each management area in proportion to the 2003-2005 salmon landings for that area. To facilitate comparison of the landings projections associated with the management alternatives (which are expressed in Table J-1 in dressed weight) to recent 2003-2005 salmon troll landings, the latter values were converted to dressed weight by multiplying the corresponding round weight estimates in Table K-1 by 87% (the round-to-dressed weight conversion used in PacFIN).

III. Commercial Salmon Troll Fleet[10]

Table K-4 describes the salmon troll fleet in each management area in terms of number of boats, total salmon landings and revenues made by these boats, and average salmon landings and revenues per boat. The fleet is categorized into salmon-only and multiple-fishery vessels to convey the extent to which vessels are likely to forego all or part of their fishery revenue in a Conservation Alert year. For all management areas combined, salmon-only vessels comprise 40% of all trollers, account for about 27% of total salmon landings and revenues, and make (on average) lower salmon landings and revenues than multiple fishery vessels. It should be noted that the averages provided in Table K-4 obscure the considerable variation in salmon revenue observed among vessels (see Figures K-3a and K-3b).

The non-salmon fisheries most commonly targeted by multiple-fishery trollers are crab pot, albacore troll and groundfish fixed gear. Table K-5 describes the extent to which multiple-fishery trollers in each management area depend on salmon relative to these other fisheries. Dependence on crab is particularly notable in virtually all management areas except Monterey, where vessels are more likely to depend on albacore and groundfish as alternative sources of income.

Table K-6 describes the number of trollers projected to participate in the salmon fishery in four management areas (Monterey, San Francisco, Coos Bay, Northern Oregon) in a Conservation Alert year under each of the de minimis alternatives. These projections were derived as follows: Using 1994-2005 data, the number of trollers associated with each management area was regressed on the number of days that the season was open in that area (see Table K-1). The number of salmon fishery participants under each of the de minimis alternatives was predicted, based on the regression coefficients provided in Table K-1 A and the season structure for each management area assumed for each of the de minimis alternatives (from 4-15 of this EA). The medium estimates provided in Table K-6 correspond to the regression coefficients and the low/high estimates correspond to the lower/upper bound of those coefficients.

[10] For purposes of Tables 4-6, vessels were assigned to the management area associated with their port assignment. The port assignment method is described in Footnote 2.

Appendix Table I-1. Port dependence on the salmon troll fishery, as reflected in share of port landings (1000s of pounds round weight), ex-vessel value ($1000s, base year=2005) and vessel participation attributable to salmon.

Mgmt Area Port	2003-2005 Average								
	Landings			Ex-Vessel Value			# Vessels		
	Salmon	Total	%Sal	Salmon	Total	%Sal	Sal	Total	%Sal
Monterey:									
Monterey	147.1	5,024.1	6%	$ 351.6	$ 2,096.1	24%	43	65	67%
Moss Landing	449.2	40,402.9	1%	$ 1,087.5	$ 7,154.0	20%	74	112	66%
Santa Cruz	221.9	515.0	43%	$ 578.5	$ 914.9	60%	38	58	66%
SanFrancisco:									
Princeton	803.4	4,198.0	27%	$ 2,032.7	$ 5,158.5	41%	76	107	70%
San Francisco	1,099.4	7,259.1	20%	$ 2,566.4	$ 8,813.1	32%	62	153	41%
Bodega Bay	1,112.2	2,572.4	47%	$ 2,350.2	$ 4,591.0	55%	109	144	76%
Fort Bragg:									
Point Arena	47.5	739.9	7%	$ 118.6	$ 570.0	22%	8	20	40%
Fort Bragg	2,051.6	6,663.4	28%	$ 4,213.0	$ 7,721.4	53%	93	144	64%
KMZ-CA:									
Eureka	71.9	15,937.5	0%	$ 177.9	$ 10,389.8	2%	28	77	38%
Crescent City	136.1	11,386.2	1%	$ 364.5	$ 14,894.8	2%	31	109	28%
KMZ-OR:									
Brookings	85.5	5,134.7	2%	$ 215.7	$ 6,312.9	4%	22	61	36%
Coos Bay:									
Port Orford	141.2	1,937.1	8%	$ 394.7	$ 3,173.7	13%	26	63	42%
Coos Bay	1,259.4	26,492.1	5%	$ 3,169.6	$ 20,074.2	16%	123	188	65%
Winchester Bay	87.3	845.8	11%	$ 215.9	$ 1,386.8	16%	28	37	74%
Northern OR:									
Newport	1,451.9	96,850.9	2%	$ 3,544.0	$ 27,001.1	13%	147	232	63%
Tillamook	229.6	3,897.5	6%	$ 538.8	$ 3,594.1	15%	58	82	71%

Appendix Table I-2. Port dependence on the salmon troll fishery, as reflected in ex-vessel value of landings ($1000s, base Year=2005) in salmon troll fishery and all other fisheries that account for at least 5% of 2003-2005 average annual ex-vessel revenue.

Port Fishery	94-05 Avg $1000s	94-05 Avg %ofport$	2003	2004	2005	03-05 Avg $1000s	03-05 Avg %ofport$
Monterey:							
Salmon troll	$ 1,291.8	16%	$ 156.5	$ 436.4	$ 462.0	$ 351.6	17%
Squid seine	$ 1,846.6	23%	$ 2,151.6	$ 670.1	$ 256.4	$ 1,026.0	49%
Shrimp/prawn pot	$ 1,157.5	14%	$ 374.0	$ 289.2	$ 150.6	$ 271.2	13%
Non-wht grdfsh trwl	$ 943.4	12%	$ 274.8	$ 324.8	$ 96.2	$ 231.9	11%
Rock/ling fixed	$ 798.1	10%	$ 82.7	$ 145.1	$ 77.8	$ 101.9	5%
All else	$ 1,982.4	25%	$ 192.4	$ 133.1	$ 14.7	$ 113.4	5%
Total	$ 8,019.8	100%	$ 3,232.0	$ 1,998.7	$ 1,057.7	$ 2,096.1	100%
Moss Landing:							
Salmon troll	$ 1,291.8	16%	$ 498.5	$ 1,166.2	$ 1,597.5	$ 1,087.4	15%
Squid seine	$ 1,846.6	23%	$ 6,269.7	$ 2,279.9	$ 747.7	$ 3,099.1	43%
CPS seine	$ 1,157.5	14%	$ 715.6	$ 1,559.8	$ 425.4	$ 900.3	13%
Non-wht grdfsh trwl	$ 943.4	12%	$ 993.1	$ 836.9	$ 566.2	$ 798.7	11%
Sablefish fixed	$ 798.1	10%	$ 625.1	$ 444.1	$ 239.6	$ 436.3	6%
All else	$ 1,982.4	25%	$ 1,194.8	$ 843.0	$ 458.9	$ 832.2	12%
Total	$ 8,019.8	100%	$10,296.7	$ 7,129.9	$ 4,035.4	$ 7,154.0	100%
Santa Cruz:							
Salmon troll	$ 606.0	47%	$ 247.7	$ 679.8	$ 807.9	$ 578.5	63%
Crab pot	$ 116.6	9%	$ 139.4	$ 179.6	$ 88.2	$ 135.7	15%
Albacore troll	$ 48.6	4%	$ 67.3	$ 56.1	$ 7.7	$ 43.7	5%
All else	$ 511.7	40%	$ 173.2	$ 181.2	$ 116.8	$ 157.1	17%
Total	$ 1,282.8	100%	$ 627.5	$ 1,096.7	$ 1,020.6	$ 914.9	100%
Princeton:							
Salmon troll	$ 1,968.8	34%	$ 499.9	$ 3,389.5	$ 2,208.7	$ 2,032.7	39%
Crab pot	$ 1,702.0	29%	$ 2,717.0	$ 2,446.0	$ 479.3	$ 1,880.8	37%
Non-wht grdfsh trwl	$ 1,131.7	20%	$ 715.3	$ 674.9	$ 721.8	$ 704.0	14%
Squid seine	$ 227.4	4%	$ 973.2	$ 93.7	$ 0.0	$ 355.6	7%
AllElse	$ 774.7	13%	$ 222.1	$ 192.0	$ 142.1	$ 185.4	4%
Total	$ 5,804.7	100%	$ 5,127.6	$ 6,796.0	$ 3,551.9	$ 5,158.5	100%
San Francisco:							
Salmon troll	$ 1,432.6	13%	$ 1,021.9	$ 4,542.4	$ 2,134.8	$ 2,566.4	29%
Crab pot	$ 2,078.1	19%	$ 3,516.2	$ 5,119.4	$ 557.9	$ 3,064.5	35%
Non-wht grdfsh trwl	$ 1,832.1	17%	$ 1,153.0	$ 1,600.2	$ 1,297.7	$ 1,350.3	15%
Swordfish longline	$ 220.1	2%	$ 1,316.8	$ 241.1	$ 0.0	$ 519.3	6%
Herring gillnet/dive	$ 3,713.1	35%	$ 726.5	$ 475.6	$ 36.6	$ 412.9	5%
All else	$ 1,427.7	13%	$ 1,402.5	$ 896.3	$ 400.4	$ 899.7	10%
Total	$10,703.8	100%	$ 9,136.9	$12,874.9	$ 4,427.4	$08,813.1	100%
Bodega Bay:							
Salmon troll	$ 1,397.5	27%	$ 2,843.5	$ 2,661.9	$ 1,545.1	$ 2,350.2	51%
Crab pot	$ 1,886.5	36%	$ 2,262.0	$ 3,067.3	$ 610.2	$ 1,979.8	43%
All else	$ 1,901.3	37%	$ 478.8	$ 227.3	$ 77.1	$ 261.0	6%
Total	$ 5,185.3	100%	$ 5,584.3	$ 5,956.5	$ 2,232.3	$ 4,591.0	100%

Point Arena:							
Salmon troll	$ 49.3	4%	$ 81.6	$ 184.3	$ 89.7	$ 118.6	21%
Urchin dive/net	$ 997.7	87%	$ 509.4	$ 349.3	$ 149.0	$ 335.9	59%
Rock/ling fixed	$ 52.2	5%	$ 33.9	$ 91.8	$ 57.0	$ 60.9	11%
Crab pot	$ 38.6	3%	$ 81.2	$ 64.1	$ 15.4	$ 53.6	9%
All else	$ 4.8	0%	$ 1.4	$ 0.6	$ 1.3	$ 1.1	0%
Total	$ 1,142.6	100%	$ 707.5	$ 690.0	$ 312.5	$ 570.0	100%
Fort Bragg:							
Salmon troll	$ 1,454.9	18%	$ 6,818.7	$ 3,446.0	$ 2,374.1	$ 4,213.0	55%
Non-wht grdfsh trwl	$ 3,077.1	37%	$ 1,650.2	$ 1,457.5	$ 1,389.9	$ 1,499.2	19%
Crab pot	$ 1,042.9	13%	$ 1,000.3	$ 1,411.3	$ 422.2	$ 944.6	12%
Sablefish fixed	$ 737.7	9%	$ 742.1	$ 772.8	$ 526.3	$ 680.4	9%
All else	$ 1,923.2	23%	$ 554.3	$ 367.0	$ 231.2	$ 384.2	5%
Total	$ 8,235.8	100%	$10,765.7	$ 7,454.7	$ 4,943.8	$ 7,721.4	100%
Eureka:							
Salmon troll	$ 125.4	1%	$ 96.7	$ 282.8	$ 154.3	$ 177.9	2%
Crab pot	$ 4,021.4	44%	$ 8,788.5	$ 8,448.4	$ 1,333.9	$ 6,190.3	60%
Non-wht grdfsh trwl	$ 2,883.7	31%	$ 2,596.6	$ 1,987.1	$ 1,928.7	$ 2,170.8	21%
Albacore troll	$ 731.9	8%	$ 611.1	$ 1,018.8	$ 274.2	$ 634.7	6%
Shrimp trawl	$ 596.8	7%	$ 327.9	$ 618.9	$ 535.8	$ 494.2	5%
All else	$ 828.2	9%	$ 645.9	$ 881.5	$ 638.4	$ 721.9	7%
Total	$ 9,187.4	100%	$13,066.7	$13,237.4	$ 4,865.2	$10,389.8	100%
Crescent City:							
Salmon troll	$ 106.3	1%	$ 97.1	$ 925.3	$ 71.0	$ 364.5	2%
Crab pot	$ 8,530.3	59%	$15,398.7	$18,170.0	$ 4,273.9	$12,614.2	85%
Non-wht grdfsh trwl	$ 2,140.0	15%	$ 1,160.5	$ 472.9	$ 699.3	$ 777.6	5%
All else	$ 3,604.5	25%	$ 1,143.3	$ 1,195.0	$ 1,077.5	$ 1,138.6	8%
Total	$14,381.1	100%	$17,799.5	$20,763.1	$ 6,121.8	$14,894.8	100%
Brookings:							
Salmon troll	$ 135.1	2%	$ 99.4	$ 357.9	$ 189.9	$ 215.7	3%
Crab pot	$ 2,876.7	47%	$ 4,954.1	$ 7,704.1	$ 1,769.2	$ 4,809.1	76%
Non-wh grdfsh trwl	$ 1,549.7	25%	$ 1,241.2	$ 580.5	$ 739.0	$ 853.6	14%
All else	$ 1,532.6	25%	$ 491.2	$ 244.9	$ 567.3	$ 434.5	7%
Total	$ 6,094.0	100%	$ 6,785.9	$ 8,887.5	$ 3,265.4	$ 6,312.9	100%
Port Orford:							
Salmon troll	$ 192.4	7%	$ 252.7	$ 497.7	$ 433.8	$ 394.7	12%
Crab pot	$ 1,213.7	41%	$ 818.7	$ 3,399.2	$ 967.4	$ 1,728.4	55%
Sablefish fixed	$ 658.6	22%	$ 557.9	$ 489.1	$ 635.4	$ 560.8	18%
Rock/ling fixed	$ 587.0	20%	$ 407.1	$ 436.2	$ 387.8	$ 410.4	13%
All else	$ 312.6	11%	$ 54.7	$ 104.2	$ 79.2	$ 79.4	3%
Total	$ 2,964.3	100%	$02,091.1	$ 4,926.2	$ 2,503.6	$ 3,173.7	100%
Coos Bay:							
Salmon troll	$ 1,311.6	8%	$ 2,573.3	$ 3,941.2	$ 2,994.4	$ 3,169.6	16%
Crab pot	$ 4,272.7	26%	$ 6,468.8	$14,594.2	$ 5,652.5	$ 8,905.2	44%
Non-wht grdfsh trwl	$ 5,516.7	34%	$ 3,759.6	$ 2,815.8	$ 2,395.3	$ 2,990.2	15%
Albacore troll	$ 1,067.4	7%	$ 1,138.5	$ 2,709.9	$ 2,016.3	$ 1,954.9	10%
Shrimp trawl	$ 2,659.7	16%	$ 1,595.5	$ 417.8	$ 1,764.8	$ 1,259.4	6%
Sablefish fixed	$ 985.8	6%	$ 1,007.8	$ 978.4	$ 1,370.5	$ 1,118.9	6%
All else	$ 489.9	3%	$ 507.0	$ 572.9	$ 948.0	$ 676.0	3%
Total	$16,303.8	100%	$17,050.5	$26,030.3	$17,141.9	$20,074.2	100%

Winchester Bay:							
Salmon troll	$ 142.1	11%	$ 172.7	$ 278.2	$ 196.8	$ 215.9	16%
Crab pot	$ 917.5	72%	$ 1,030.6	$ 784.4	$ 1,042.8	$ 952.6	69%
Albacore troll	$ 111.1	9%	$ 188.6	$ 101.3	$ 191.4	$ 160.4	12%
All else	$ 106.9	8%	$ 110.8	$ 31.9	$ 30.9	$ 57.8	4%
Total	$ 1,277.6	100%	$ 1,502.6	$ 1,195.8	$ 1,461.9	$ 1,386.8	100%
Newport::							
Salmon troll	$ 2,272.8	9%	$ 3,289.3	$ 4,061.7	$ 3,280.9	$ 3,544.0	13%
Crab pot	$ 7,173.9	29%	$10,471.9	$12,249.3	$ 6,766.1	$ 9,829.1	36%
Albacore troll	$ 3,088.7	12%	$ 3,447.0	$ 3,992.8	$ 3,098.7	$ 3,512.9	13%
Whiting trawl	$ 3,423.0	14%	$ 2,183.6	$ 3,284.5	$ 4,827.4	$ 3,431.8	13%
Non-wht grdfsh trwl	$ 4,418.3	18%	$ 2,916.2	$ 2,550.2	$ 2,033.7	$ 2,500.1	9%
Shrimp trawl	$ 2,619.7	11%	$ 1,602.5	$ 2,294.0	$ 2,321.7	$ 2,072.7	8%
Sablefish fixed	$ 1,735.0	7%	$ 1,954.5	$ 2,132.5	$ 1,850.2	$ 1,979.1	7%
All else	$ 325.9	1%	$ 179.5	$ 79.2	$ 135.9	$ 131.5	1%
Total	$25,057.5	100%	$26,044.4	$30,644.3	$24,314.5	$27,001.1	100%
Tillamook:							
Salmon troll	$ 290.4	11%	$ 468.8	$ 422.5	$ 725.1	$ 538.8	15%
Crab pot	$ 1,230.7	47%	$ 1,963.0	$ 2,592.2	$ 1,531.4	$ 2,028.8	56%
Shrimp trawl	$ 542.5	21%	$ 666.7	$ 382.1	$ 756.5	$ 601.8	17%
Albacore troll	$ 199.5	8%	$ 215.5	$ 154.8	$ 212.0	$ 194.1	5%
All else	$ 651.0	25%	$ 785.1	$ 691.8	$ 831.4	$ 769.4	21%
Total	$ 2,623.8	100%	$ 3,630.3	$ 3,820.9	$ 3,331.2	$ 3,594.1	100%

Table I-3. Average 2003-2005 salmon troll landings and projected landings in Conservation Alert years (1000s of pounds dressed weight) under four alternatives (status quo, 5%, 10% and 13%) and three scenarios (low, medium, high CPUE) - by management area and port.

Mgmt Area	03-05 Avg Salmon Landings		Status	5% Alternative			10% Alternative			13% Alternative		
Port	(1000 lbs)		Quo	Low	Medium	High	Low	Medium	High	Low	Medium	High
Monterey:												
Monterey	128.0	18%	0	33.7	61.6	105.8	129.0	235.4	404.5	157.2	286.9	492.9
Moss Landing	390.8	55%	0	103.1	188.1	323.1	394.2	719.4	1,235.9	480.5	876.7	1,506.1
Santa Cruz	193.1	27%	0	50.6	92.3	158.6	193.5	353.2	606.7	0.0	0.0	0.0
Other	0.2	0%	0	0.0	0.0	0.0	0.0	0.0	0.0	873.6	1,594.0	2,738.3
Total	712.0	100%	0	187.4	342.0	1,587.5	716.8	1,308.0	2,247.0			
San Francisco:												
Princeton												
San Francisco	699.0	26%	0	84.2	131.9	210.5	83.7	130.9	209.1	83.7	130.9	209.1
Bodega Bay	956.5	36%	0	115.2	180.4	288.1	115.9	181.3	289.5	115.9	181.3	289.5
Other	967.6	36%	0	116.5	182.8	291.5	115.9	181.3	289.5	115.9	181.3	289.5
Total	35.9	2%	0	3.3	6.0	10.4	6.4	10.1	16.1	6.4	10.1	16.1
	2,670.1	100%	0	321.6	503.7	804.3	321.6	503.6	804.2	321.9	503.6	804.2
Coos Bay:												
Port Orford	122.8	9%	0	2.5	6.9	10.0	5.5	15.1	21.9	7.1	19.3	28.0
Coos Bay	1,095.7	82%	0	23.0	63.0	91.3	50.3	137.4	199.3	64.3	175.6	254.7
WinchesterBay	76.0	6%	0	1.7	4.6	6.7	3.7	10.1	14.6	4.7	12.8	18.6
Other	47.2	3%	0	0.8	2.3	8.3	1.8	5.0	7.3	2.4	6.4	9.3
Total	1,341.7	100%	0	28.1	76.8	111.4	61.3	167.5	243.1	78.4	214.1	310.6
Northern OR:												
Newport	1,263.1	85%	0	279.5	581.5	944.9	281.7	586.2	952.6	323.9	674.1	1,095.6
Tillamook	199.7	14%	0	46.0	95.8	155.6	46.4	96.5	156.9	53.4	111.1	1809.4
Other	19.2	1%	0	3.3	6.8	11.1	3.3	6.9	11.2	3.8	7.9	12.9
Total	1,482.0	100%	0	328.8	684.1	1,111.7	331.4	689.6	1,120.7	381.1	793.1	1,288.9

Table I-4. Average number of salmon-only and multiple-fishery trollers who fished for salmon during 2003-2005 and 1994-2005 and associated total and average salmon landings and revenues, by management area. (Landings expressed in 1,000s of pounds round weight; revenue in $1000s, base year=2005)

Managemt Area	# Salmon Trollers			Total Salmon Troll Landings and Revenue						Average Salmon Landings and Revenue Per Troller					
				Landings			Revenue			Landings			Revenue		
	SalOnly	Mult	All	SalOnly	Mult	All	SalOnly	Mult	All	SalOnly	Mult	All	SalOnly	Mult	All
Monterey															
03-05 Avg	85	78	164	290.4	537.1	827.5	$ 732.3	$ 1,257.2	$ 1,989.5	3.1	7.0	5.0	$ 7.5	$16.6	$11.7
94-05 Avg	109	112	221	415.7	840.4	1,256.1	$ 767.0	$ 1,489.8	$ 2,256.7	3.3	7.3	5.3	$ 6.2	$13.5	$ 9.8
SanFran															
03–05 Avg	138	172	310	904.9	2,386.3	2,146.3	$2,199.1	$ 5,774.7	$ 7,973.8	6.5	13.4	10.4	$15.5	$31.4	$24.5
94-05 Avg	165	227	391	787.6	2,146.3	2,933.8	$1,627.1	$ 4,307.9	$ 5,935.0	4.9	9.8	7.8	$10.1	$19.6	$15.6
FortBragg															
03-05 Avg	47	68	115	699.4	1,353.7	2,053.0	$1,447.0	$ 2,648.8	$ 4,095.8	13.9	16.6	15.6	$29.8	$34.9	$32.9
94-05 Avg	29	39	68	218.1	483.8	701.8	$ 435.9	$ 906.0	$ 1,342.0	5.3	7.8	6.8	$10.7	$15.2	$13.4
KMZ-CA															
03-05 Avg	10	21	31	33.3	169.7	203.0	$ 76.9	$ 426.8	$ 503.7	4.3	7.1	6.4	$ 9.5	$17.4	$15.5
94-05 Avg	8	19	26	16.2	65.8	82.0	$ 33.3	$ 150.4	$ 183.7	2.0	2.9	2.7	$ 4.0	$ 6.5	$ 5.9
KMZ-OR															
03-05 Avg	4	12	16	5.3	54.3	59.6	$ 14.5	$ 130.3	$ 144.8	1.3	4.3	3.6	$ 3.4	$10.1	$ 8.6
94-05 Avg	5	14	18	4.4	47.1	51.6	$ 10.9	$ 94.5	$ 105.4	1.0	3.2	2.7	$ 2.4	$ 6.6	$ 5.6
CoosBay															
03-05 Avg	71	140	211	313.2	1,212.4	1,525.6	$ 778.1	$ 2,999.9	$ 3,777.9	4.4	8.7	7.2	$11.0	$21.4	$17.8
94-05 Avg	54	105	159	178.8	665.7	844.6	$ 364.2	$ 1,374.1	$ 1,738.3	3.0	5.9	4.9	$ 6.0	$11.7	$ 9.8
NorthOR															
03-05 Avg	69	152	221	778.1	2,999.9	3,777.9	$ 811.4	$ 3,161.0	$ 3,972.4	5.3	8.9	7.7	$11.7	$20.9	$18.0
94-05 Avg	84	125	209	364.2	1,374.1	1,738.3	$ 661.1	$ 1,918.5	$ 2,579.6	4.5	8.0	6.6	$ 8.1	$14.7	$12.1
Total															
03-05 Avg	423	644	1,068	2,621.1	7,013.4	9,634.4	$6,059.3	$16,398.7	$22,458.1	6.3	10.9	9.1	$14.3	$25.2	$20.9
94-05 Avg	453	641	1,093	1,998.2	5,257.6	7,255.9	$3,899.6	$10,241.3	$14,140.8	4.5	8.2	6.7	$ 8.7	$15.9	$13.0

Appendix Table I-5. Average annual 2003-2005 and 1994-2005 landings and revenues by multiple-fishery salmon trollers, by management area and fishery.

Mgmt Area Fishery	Average Landings Per Troller (1000 lbs round weight)				Average Revenue Per Troller ($1000s, Base Year=2005)			
	03-05 Average		94-05 Average		03-05 Average		94-05 Average	
Monterey:								
Salmon troll	7.0	25%	7.3	24%	$16.6	40%	$13.5	33%
Crab pot	2.6	7%	2.1	6%	4.8	11%	4.5	11%
Albacore line	8.9	30%	8.7	29%	7.4	19%	8.0	21%
Groundfish fixed	3.7	13%	4.0	14%	5.5	15%	5.7	16%
Other	12.9	25%	11.5	27%	7.4	17%	8.5	20%
Total	35.1	100%	33.6	100%	$41.8	100%	$40.2	100%
San Francisco:								
Salmon troll	13.4	34%	9.8	34%	$31.4	46%	$19.6	39%
Crab pot	16.7	37%	9.8	32%	28.8	38%	19.9	40%
Albacore line	6.9	15%	4.5	15%	5.9	8%	4 .2	9%
Groundfish fixed	1.0	3%	1.7	7%	1.9	3%	2.6	6%
Other	5.0	12%	4.0	14%	3.5	5%	3.3	7%
Total	43.1	100%	29.8	100%	$71.5	100%	$49.6	100%
Fort Bragg:								
Salmon troll	16.6	36%	7.8	26%	$34.9	47%	$15.2	31%
Crab pot	21.6	46%	9.5	37%	35.1	44%	17.9	43%
Albacore line	0.9	2%	0.6	2%	0.8	10%	0.6	1%
Groundfish fixed	2.3	6%	3.3	17%	3.8	5%	5.3	16%
Other	4.9	11%	5.0	18%	2.3	3%	2.6	9%
Total	46.4	100%	26.2	100%	$76.9	100%	$41.6	100%
KMZ-CA:								
Salmon troll	7.1	12%	2.9	12%	$17.4	15%	$ 6.5	13%
Crab pot	41.4	76%	17.5	69%	67.6	70%	31.6	72%
Albacore line	0.8	2%	0.4	2%	0.6	1%	0.4	1%
Groundfish fixed	3.0	7%	2.4	12%	5.2	6%	3.8	10%
Other	1.4	4%	0.9	4%	5.3	8%	1.6	3%
Total	53.6	100%	24.1	100%	$96.1	100%	$43.8	100%
KMZ-OR:								
Salmon troll	4.3	10%	3.2		$10.1	14%	$ 6.6	16%
Crab pot	37.0	85%	14%		60.2	82%	35.9	66%
Albacore line	0.8	1%	20.1	57%	0.7	1%	1.4	3%
Groundfish fixed	1.6	4%	1.5	5%	2.2	3%	4.6	11%
Other	0.0	0%	4.2	14%	0.0	0%	2.9	5%
Total	43.6	100%	9.6	12%	$73.2	100%	$51.4	100%
			38.6	100%				

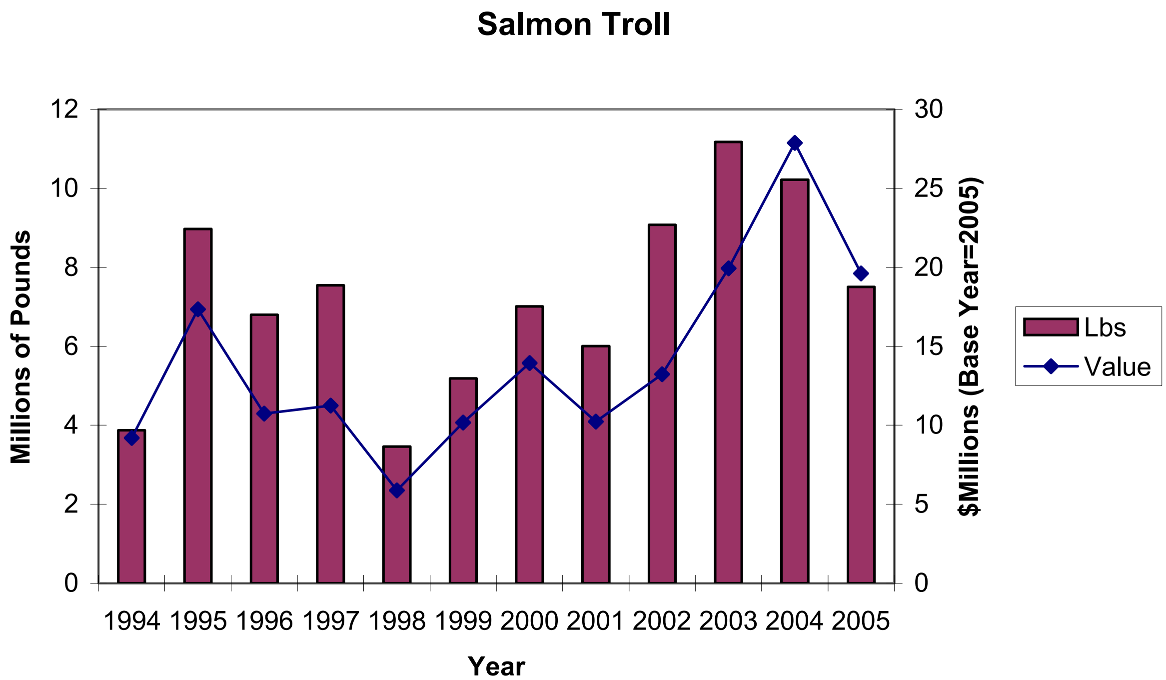
Coos Bay:								
Salmon troll	8.7	17%	5.9	17%	$21.4	28%	$11.7	23%
Crab pot	21.6	40%	11.7	32%	35.2	45%	21.8	43%
Albacore line	11.6	21%	5.3	14%	9.9	13%	4.8	9%
Groundfish fixed	4.3	9%	5.3	18%	7.5	10%	8.0	18%
Other	7.0	13%	6.2	18%	3.2	4%	3.4	8%
Total	53.2	100%	34.4	100%	$77.1	100%	$49.8	100%
North OR:								
Salmon troll	8.9		8.0	25%	$20.9		$14.7	30%
Crab pot	21%		11.1	34%	33%		20.6	43%
Albacore line	18.1	43%	8.0	26%	28.9	44%	7.3	16%
Groundfish fixed	10.5	25%	2.6	9%	9.1	14%	4.1	9%
Other	2.7	6%	1.9	6%	4.8	7%	1.2	3%
Total	2.3	6%	31.5	100%	1.3	2%	$48.0	100%
	42.4	100%			$65.0	100%		
All Areas:								
Salmon troll	10.9	24%	8.2	25%	$25.2	36%	$15.9	33%
Crab pot	18.5	40%	9.9	31%	30.5	43%	18.8	39%
Albacore line	8.1	18%	5.8	18%	7.0	10%	5.3	11%
Groundfish fixed	2.7	6%	3.1	10%	4.6	7%	4.6	10%
Other	5.6	12%	5.3	16%	3.3	5%	3.8	8%
Total	45.8	100%	32.3	100%	$70.6	100%	$48.4	100%

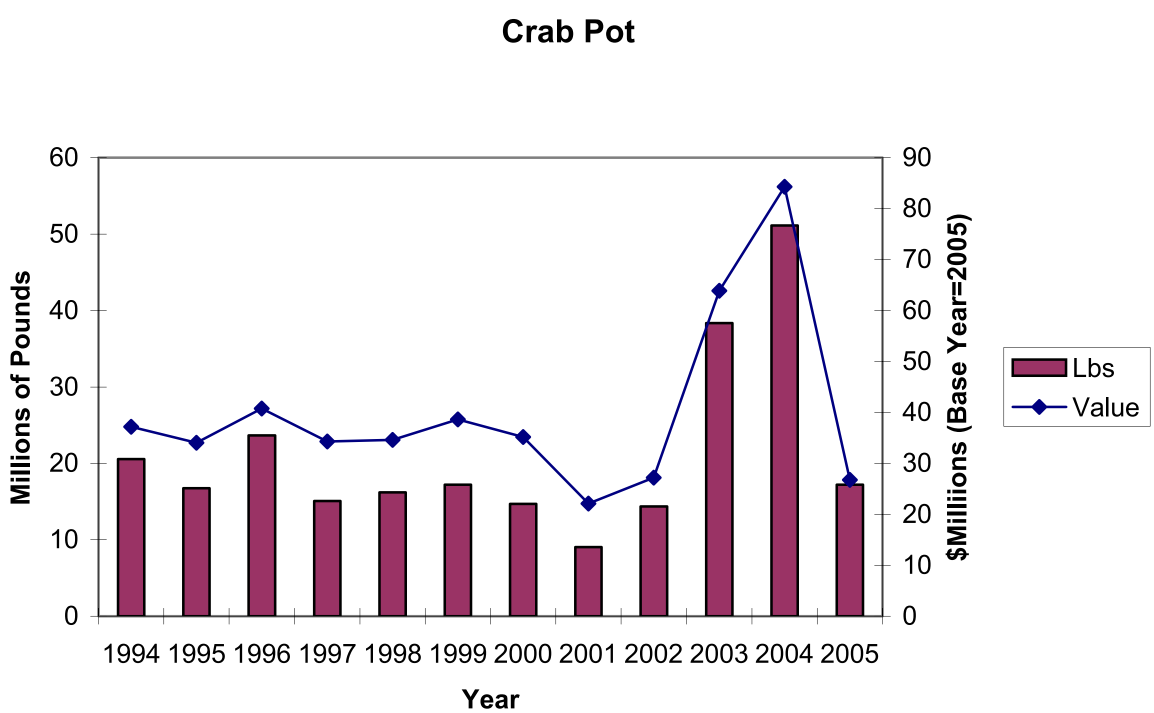
Appendix Table I-6. Average number of trollers who landed salmon during 2003-2005 and 1994-2005, and low/medium/high number of trollers projected to participate in salmon fishery in a Conservation Alert year under each alternative (status quo, 5%, 10%, 13%), by management area.

	Monterey	San Francisco	Coos Bay	North OR
Historical Average				
03-05 avg	164	310	211	221
94-05 avg	221	391	159	209
Status Quo	0	0	0	0
5% Alternative				
Low	46	73	14	74
Medium	61	85	21	101
High	77	97	28	128
10% Alternative				
Low	81	73	20	76
Medium	108	85	31	103
High	136	97	41	131
13% Alternative				
Low	92	73	23	82
Medium	123	85	35	111
High	154	97	47	141

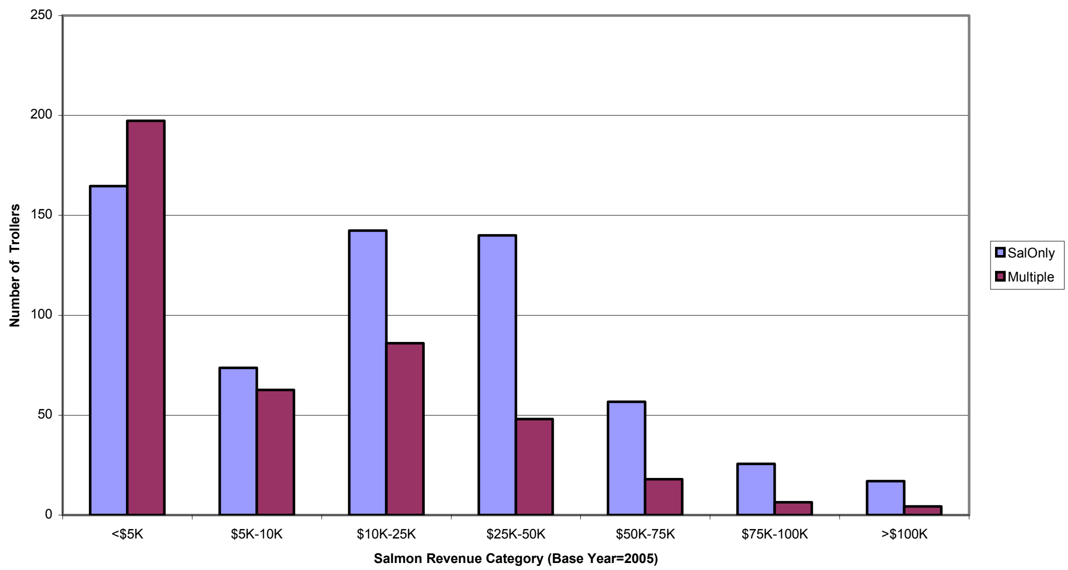
Appendix Figure K-1. Major salmon ports by Klamath management area

Appendix Figure K-2. Total landings and ex-vessel value of salmon troll and crab pot landings in Klamath management areas, 1994-2005.

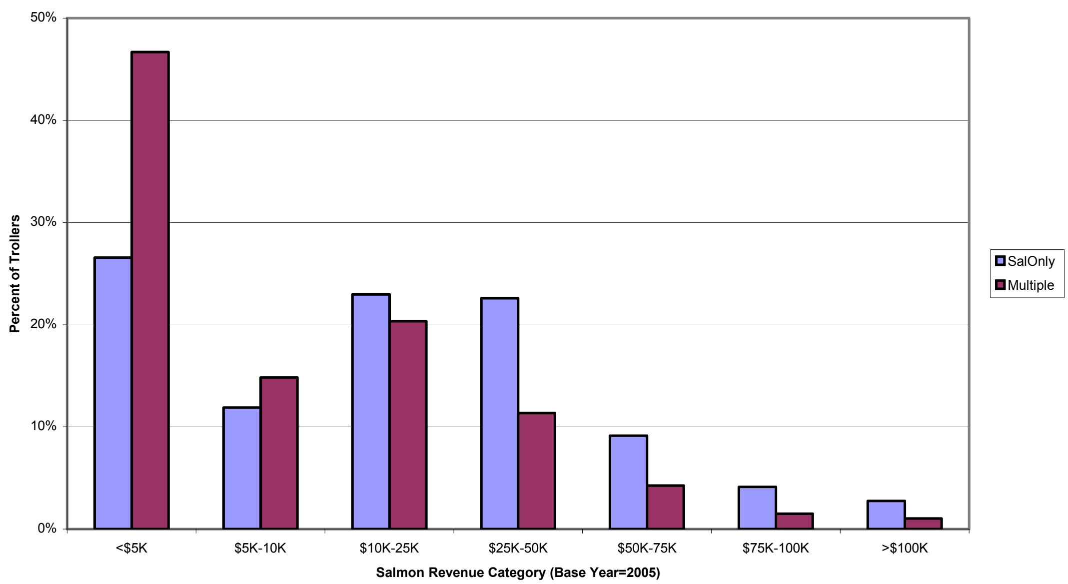




Appendix Figure K-3a. Absolute distribution of salmon-only and multiple-fishery trollers in Klamath management areas by annual salmon revenue category, 2003-2005 average.



Appendix Figure K-3b. Relative distribution of salmon-only and multiple-fishery trollers in Klamath management areas by annual salmon revenue category, 2003-2005 average.



Sub Appendix a . Troller Participation Regression

Regression equation:

$ntroller_{ij} = \beta_1$ season_mnt + β_2 season_sf + β_3 season_coos + β_4 season_north + ε_{ij}

where

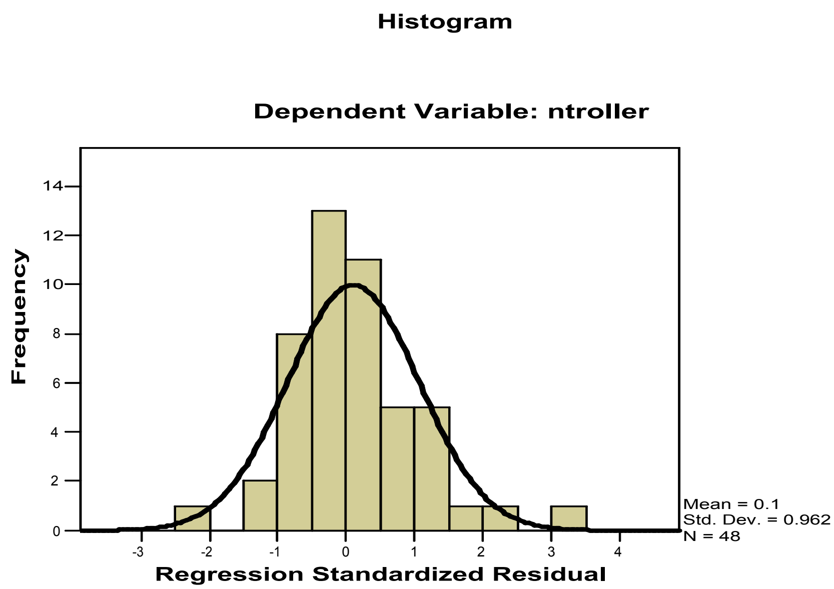
$ntroller_{ij}$ = number of trollers who landed salmon in year i (i=1994,...,2005) and made the plurality of their revenue (all fisheries) from a port in management area j (j=mnt, sf, coos, north)
$season\_mnt_{ij}$ = mntdum * $season_{ij}$
$season\_sf_{ij}$ = sfdum * $season_{ij}$
$season\_coos_{ij}$ = coosdum * $season_{ij}$
$season\_north_{ij}$ = northdum * $season_{ij}$

mntdum = 1 for Monterey management area, 0 otherwise.
sfdum = 1 for San Francisco management area, 0 otherwise
coosdum = 1 for Coos Bay management area, 0 otherwise
northdum = 1 for Northern Oregon management area, 0 otherwise
$season_{ij}$ = salmon troll season (# days) in year i and management area j
(Note: In cases where the season varied among subareas within a management area, the subarea with the longest season was used to represent the area as a whole.)

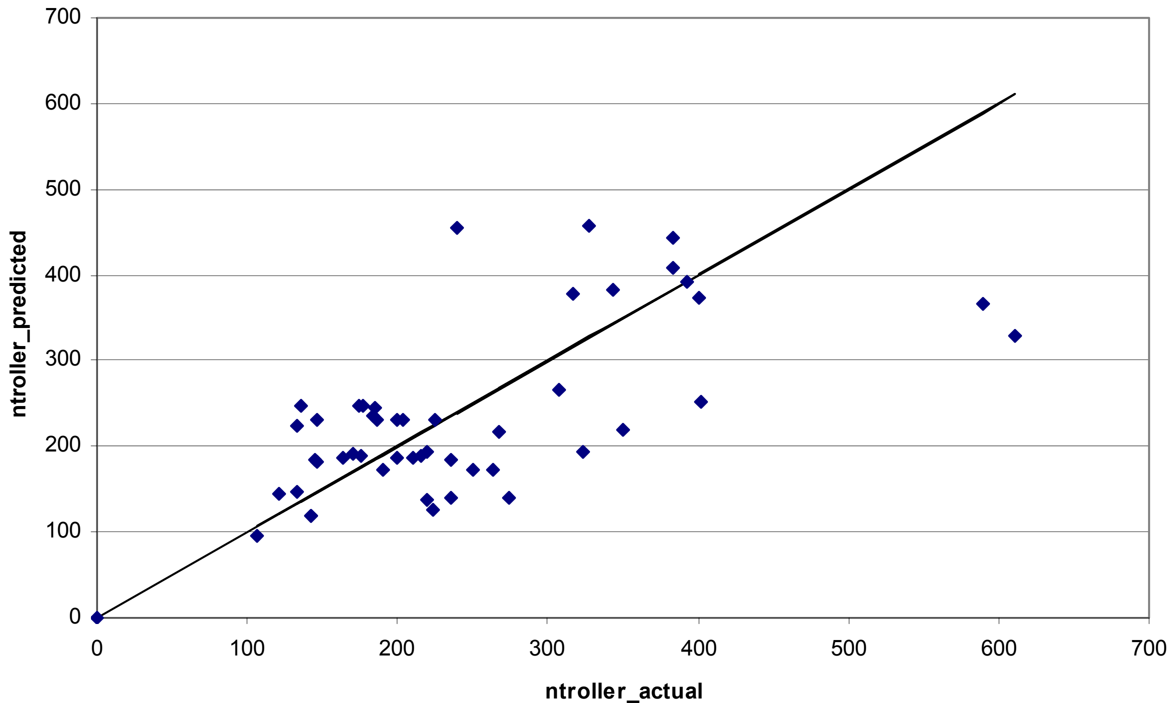
Regression results:

r^2adj=0.881, n=48					
Dependent Variable	Independent Variable	coefficient	t-value	95% confidence interval lower bound	upper bound
Ntroller	season_mnt	1.618	8.011	1.211	2.024
	season_sf	2.741	14.217	2.352	3.129
	season_coos	0.747	5.934	0.493	1.001
	season_north	1.136	7.542	0.832	1.439

Standardized residuals:



Actual versus predicted values compared to 1:1 relationship:



APPENDIX J: LOWER KLAMATH RIVER RECREATIONAL SALMON FISHERY DATA

Appendix Table J-1. Annual catch, effort, and angler expenditure for lower Klamath River recreational fisheries. (Page 1 of 3)

					Expenditures	Chinook			
Year	Sample Location[a/]	Angler Trips	Angler Hours	Hours/ Trip	/Trip $66.67	Jacks (grilse)	Adults	Total	Chinook Adult Catch/Trip
1980	Area 1	12,479	50,848	4.07	$831,975	835	727	1,562	0.06
	Area 2	16,911	53,449	3.16	$1,127,456	1,648	793	2,441	0.05
	Totals	29,390	104,297	3.55	$1,959,431	2,483	1,520	4,003	0.05
1981	Area 1	ONLY COMBINED				536	1,714	2,250	
	Area 2	INFO AVAIL				1,783	661	2,444	
	Totals	43,220	157,813	3.65	$2,881,477	2,319	2,375	4,694	0.05
1982	Area 1	22,064	97,339	4.41	$1,471,007	1,252	3,539	4,791	0.16
	Area 2	29,899	104,925	3.51	$1,993,366	2,712	1,016	3,728	0.03
	Totals	51,963	202,264	3.89	$3,464,373	3,964	4,555	8,519	0.09
1983	Area 1		NO INFO			60	750	810	
	Area 2		AVAILABLE			113	555	668	
	Totals	0	0			173	1,305	1,478	
1984	Area 1	22,844	60,614	2.65	$1,523,009	175	548	723	0.02
	Area 2	14,938	49,884	3.34	$995,916	256	257	513	0.02
	Totals	37,782	110,498	2.92	$2,518,926	431	805	1,236	0.02
1985	Area 1	21,399	68,070	3.18	$1,426,671	1,479	2,427	3,906	0.11
	Area 2	18,761	70,171	3.74	$1,250,796	2,331	438	2,769	0.02
	Totals	40,160	138,241	3.44	$2,677,467	3,810	2,865	6,675	0.07
1986	Area 1	28,274	89,092	3.15	$1,885,028	704	2,456	3,160	0.09
	Area 2	18,156	71,564	3.94	$1,210,461	2,257	2,661	4,918	0.15
	Totals	46,430	160,656	3.46	$3,095,488	2,961	5,117	8,078	0.11
1987	Area 1	26,292	79,534	3.03	$1,752,888	146	2,455	2,601	0.09
	Area 2	24,972	99,047	3.97	$1,664,883	2,980	5,648	8,628	0.23
	Totals	51,264	178,581	3.48	$3,417,771	3,126	8,103	11,229	0.16
1988	Area 1	34,126	109,022	3.19	$2,275,180	124	3,367	3,491	0.10
	Area 2	29,945	116,993	3.91	$1,996,433	2,042	5,317	7,359	0.18
	Totals	64,071	226,015	3.53	$4,271,614	2,166	8,684	10,850	0.14
1989	Area 1	31,157	96,814	3.11	$2,077,237	137	1,328	1,465	0.04
	Area 2	24,775	102,276	4.13	$1,651,749	1,921	3,254	5,175	0.13
	Totals	55,932	199,090	3.56	$3,728,986	2,058	4,582	6,640	0.08
1990	Area 1	14,952	46,778	3.13	$996,850	58	291	349	0.02
	Area 2	22,187	92,177	4.15	$1,479,207	1,376	1,934	3,310	0.09
	Totals	37,139	138,955	3.74	$2,476,057	1,434	2,225	3,659	0.06
1991	Area 1	8,119	24,359	3.00	$541,294	19	314	333	0.04

	Area 2	11,841	54,298	4.59	$789,439	336	1,010	1,346	0.09
	Totals	19,960	78,657	3.94	$1,330,733	355	1,324	1,679	0.07

Appendix Table J-1. Annual catch, effort, and angler expenditure for lower Klamath River recreational fisheries. (Page 2 of 3)

Year	Sample Location[a/]	Angler Trips	Angler Hours	Hours/ Trip	Expenditures /Trip $66.67	Chinook Jacks (grilse)	Adults	Total	Chinook Adult Catch/Trip
1992	Area 1	2,349	6,277	2.67	$156,608	13	20	33	0.01
	Area 2	8,841	26,803	3.03	$589,429	2,364	393	2,757	0.04
	Totals	11,190	33,080	2.96	$746,037	2,377	413	2,790	0.04
1993	Area 1	6,261	19,613	3.13	$417,421	23	669	692	0.11
	Area 2	9,820	32,276	3.29	$654,699	1,064	908	1,972	0.09
	Totals	16,081	51,889	3.23	$1,072,120	1,087	1,577	2,664	0.10
1994	Area 1	6,769	21,394	3.16	$451,289	246	662	908	0.10
	Area 2	5,064	19,100	3.77	$337,617	1,161	181	1,342	0.04
	Totals	11,833	40,494	3.42	$788,906	1,407	843	2,250	0.07
1995	Area 1	10,906	25,790	2.36	$727,103	323	956	1,279	0.09
	Area 2	8,975	37,579	4.19	$598,363	2,074	626	2,700	0.07
	Totals	19,881	63,369	3.19	$1,325,466	2,397	1,582	3,979	0.08
1996	Area 1	16,535	46,220	2.80	$1,102,388	100	3,110	3,210	0.19
	Area 2	11,394	44,799	3.93	$759,638	1,128	4,052	5,180	0.36
	Totals	27,929	91,019	3.26	$1,862,026	1,228	7,162	8,390	0.26
1997	Area 1	9,699	32,166	3.32	$646,632	49	2,182	2,231	0.22
	Area 2	5,534	17,209	3.11	$368,952	1,226	512	1,738	0.09
	Totals	15,233	49,375	3.24	$1,015,584	1,275	2,694	3,969	0.18
1998	Area 1	9,122	29,316	3.21	$608,164	124	1,603	1,727	0.18
	Area 2	8,484	22,829	2.69	$565,628	406	1,270	1,676	0.15
	Totals	17,606	52,145	2.96	$1,173,792	530	2,873	3,403	0.16
1999	Area 1	3,254	8,748	2.69	$216,944	37	177	214	0.05
Prelim	Area 2	7,051	33,688	4.78	$470,090	869	1,112	1,981	0.16
	Totals	10,305	42,436	4.12	$687,034	906	1,289	2,195	0.13
2000	Area 1	6,264	20,016	3.20	$417,621	108	1,190	1,298	0.19
	Area 2	6,963	33,017	4.74	$464,223	972	1,006	1,978	0.14
	up area 2	948	4,151	4.38	$63,203	0	2	2	0.00
	Area 3	7,153	23,593	3.30	$476,891	117	1,547	1,664	0.22
		21,328	80,777	3.79	$1,421,938	1,197	3,745	4,942	0.18
2001	Area 1	9,010	35,052	3.89	$600,713	298	4,620	4,918	0.51
	Area 2	8,062	41,956	5.20	$537,480	825	1,960	2,784	0.24
	Area 3				$0	242	3,041	3,283	
		17,072	77,009	4.51	$1,138,193	1,365	9,621	10,985	
2002	Area 1	7,249	30,151	4.16	$483,280	274	3,285	3,559	0.45
	Area 2	7,925	43,211	5.45	$528,347	284	3,268	3,552	0.41
	Area 3					93	3,216	3,309	
		15,174	73,362	4.83	$1,011,627	651	9,769	10,420	

Appendix Table J-1. Annual catch, effort, and angler expenditure for lower Klamath River recreational fisheries. (Page-3 of 3)

Year	Sample Location[a/]	Angler Trips	Angler Hours	Hours/ Trip	Expenditures /Trip $66.67	Chinook Jacks (grilse)	Chinook Adults	Chinook Total	Chinook Adult Catch/Trip
2003	Area 1	7,734	32,066	4.15	$515,651	180	1589	1,769	0.21
	Area 2	8,198	44,454	5.42	$546,545	369	3336	3,705	0.41
	Area 3					40	2397	2,437	
		15,932	76,520	4.80	$1,062,196	589	7,322	7,911	
2004	Area 1	6827	26806	3.93	$455,177	748	725	1,473	0.11
	Area 2	8352	44591	5.34	$556,843	1493	1472	2,965	0.18
	Area 3					52	1266	1,318	
2005	Area 1	4,616	20,211	4.38	$307,746	311	243	554	0.05
	Area 2	6,444	35,007	5.43	$429,606	595	468	1,063	0.07
	Area 3					6	318	324	
		11,060	55,218	4.99	$737,352	912	1,029	1,941	

Area 1 = Mouth to 101 Bridge; Area 2 = 101 Bridge to Coon Creek Falls (rm35); Area 3 = Coon Creek Falls to Iron Gate Dam.