Ocean Sport Fishing Economics Technical Report

For the Secretarial Determination on Whether to Remove Four Dams on the Klamath River in California and Oregon

Prepared by

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Acronyms and Abbreviations

AAA	American Automobile Association
CDFG	California Department of Fish and Game
DPV	Discounted Present Value
DRA	Dam Removal Alternative
EDRRA	Evaluation of Dam Removal and Restoration of Anadromy
EEZ	Exclusive Economic Zone
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FMP	Fishery Management Plan
IGD	Iron Gate Dam
IMPLAN	Impact Analysis for Planning
KBRA	Klamath Basin Restoration Agreement
KMZ	Klamath Management Zone
KMZ-CA	Klamath Management Zone – California
KMZ-OR	Klamath Management Zone – Oregon
KRFC	Klamath River Fall Chinook
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
NAA	No Action Alternative
NED	National Economic Development
NEV	Net Economic Value
NMFS	National Marine Fisheries Service
ODFW	Oregon Department of Fish and Wildlife
PFMC	Pacific Fishery Management Council
RED	Regional Economic Development
SONCC	Southern Oregon Northern California Coast
SRFC	Sacramento River Fall Chinook
USFWS	U.S. Fish and Wildlife Service
USDOI	U.S. Department of the Interior
USWRC	U.S. Water Resources Council

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I. Introduction

In March 2012, the Secretary of the Interior – in consultation with the Secretary of Commerce – will make a determination regarding whether removal of four Klamath River dams (Iron Gate, Copco 1, Copco 2 and J.C. Boyle) owned by the utility company PacifiCorp advances restoration of salmonid fisheries and is in the public interest. One of the fisheries potentially affected by the Secretarial Determination is the ocean recreational salmon fishery. This report analyzes the economic effects on that fishery of three alternatives that will be considered by the Secretary:

- Alternative 1 – No Action: This alternative involves continued operation of the four dams under current conditions, which include no fish passage and compliance with Biological Opinions by the U.S. Fish and Wildlife Service (USFWS) and NOAA National Marine Fisheries Service (NMFS) regarding the Bureau of Reclamation's Klamath Project Operation Plan.
- Alternative 2 – Full Facilities Removal of Four Dams: This alternative involves complete removal of all features of the four dams, implementation of the Klamath Basin Restoration Agreement (KBRA 2010), and transfer of Keno Dam from PacifiCorp to the U.S. Department of the Interior (USDOI).
- Alternative 3 – Partial Facilities Removal of Four Dams: This alternative involves removal of selected features of each dam to allow a free flowing river and volitional fish passage for all anadromous species. Features that remain in place (e.g., powerhouses, foundations, tunnels, pipes) would be secured and maintained in perpetuity. The KBRA and transfer of Keno Dam are also part of this alternative.

Throughout this report, Alternative 1 is referred to as the no action alternative and Alternatives 2 and 3 as the action alternatives.

Section II describes existing conditions in the ocean recreational fishery and Section III describes the biological sources of information underlying the analysis of fishery effects. Sections IV and V respectively analyze the alternatives in terms of two 'accounts' specified in guidelines provided by the U.S. Water Resources Council (USWRC 1983): Net Economic Development (NED) and Regional Economic Development (RED). NED pertains to analysis of economic benefits and costs from a national perspective and RED pertains to analysis of regional economic impacts in terms of jobs, income and output. Sections VI summarizes results and conclusions of the previous sections, and Section VII provides a list of references cited in the report. Appendices A-C supplement the report with additional technical information.

II. Existing Fishery Conditions

The particular salmon stocks influenced by the no action and action alternatives are the two component populations of the Upper Klamath-Trinity Evolutionarily Significant Unit (ESU)[1] (Klamath River fall and spring Chinook) and the Southern Oregon Northern California Coast (SONCC) coho ESU. These stocks (like other salmon stocks that originate in rivers south of Cape Falcon, Oregon) generally limit their ocean migration to the area south of Cape Falcon. The area south of Falcon is divided into six fishery management areas: Monterey, San Francisco, Fort Bragg, Klamath Management Zone (KMZ), Central Oregon, and Northern Oregon. For purposes of this analysis, the KMZ (which straddles the Oregon-California border) is divided at the border into two areas: KMZ-OR and KMZ-CA (Figure II-1). To the extent possible, the effects of the alternatives are analyzed separately for each area (including KMZ-OR and KMZ-CA).

Figure II-1. Ocean salmon management areas south of Cape Falcon, Oregon (graphic by Holly Davis).

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[1] An Evolutionarily Significant Unit is a population or group of populations that is reproductively isolated and of substantial ecological/genetic importance to the species (Waples 1991).

SONCC coho and Klamath Chinook co-mingle with other salmon stocks in the ocean recreational fishery. The Pacific Fishery Management Council (PFMC) manages such 'mixed stock' fisheries on the principle of 'weak stock management' whereby harvests of healthier stocks are constrained more by the need to protect weaker stocks than by their own abundance.[2] The implications of weak stock management as it relates to SONCC coho and Klamath Chinook are as follows.

- PFMC-managed ocean fisheries south of Cape Falcon are subject to consultation standards for two Chinook and four coho ESUs listed under the Endangered Species Act (ESA) – including the SONCC coho ESU (listed in 1997). To meet consultation standards for the coho ESUs, the PFMC banned coho retention in the ocean recreational fishery south of Cape Falcon in 1994. In California, this ban remains in effect to this day. In Oregon, the ban was replaced in 1999 by a coho mark-selective fishery[3] with a marked coho quota and season limits to ensure that the recreational fishery does not exceed maximum allowable exploitation rates for ESA-listed stocks (PFMC 2011).

- The major salmon stocks targeted by ocean fisheries south of Cape Falcon are Sacramento River fall Chinook (SRFC) and Klamath River fall Chinook (KRFC). For most of the past three decades, KRFC has been more constraining than SRFC on the ocean recreational fishery in KMZ-CA and KMZ-OR. That is, regulations devised to limit harvest of KRFC in the KMZ necessarily constrain SRFC harvest as well to levels below what would have been allowed in the absence of the KRFC constraint.

Figure II-2 depicts recent trends in the ocean recreational fishery. Recreational harvest (Chinook+coho, numbers of fish) south of Cape Falcon ranged from 232,000 to 506,000 during 1981-92, fell to 101,000-326,000 during 1993-05, and declined further to 30,000-119,000 during 2006-10; effort followed a similar pattern. A number of factors contributed to that decline – e.g., the more conservative harvest control rule for KRFC adopted in 1989, implementation of weak stock management policies in the 1990s, the spate of ESA listings that occurred during the 1990s, and the 50-50 tribal/non-tribal allocation of Klamath-Trinity River salmon implemented in 1993. These regulatory changes were compounded by drought and El Niño conditions during 1991-92 and 1997-98 that contributed to low recreational landings in 1993-94 and 1998-99. The record low landings and effort experienced during 2006-10 is due to the conservation concerns declared by the PFMC in 2006 for KRFC and in the late 2000s for SRFC (Appendix A).

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[2] See Appendix A for a description of PFMC salmon management.

[3] A mark selective fishery is a fishery in which hatchery fish are marked in a visually identifiable manner (e.g., by clipping the adipose fin), thereby allowing anglers to selectively retain marked fish and release unmarked (wild) fish.

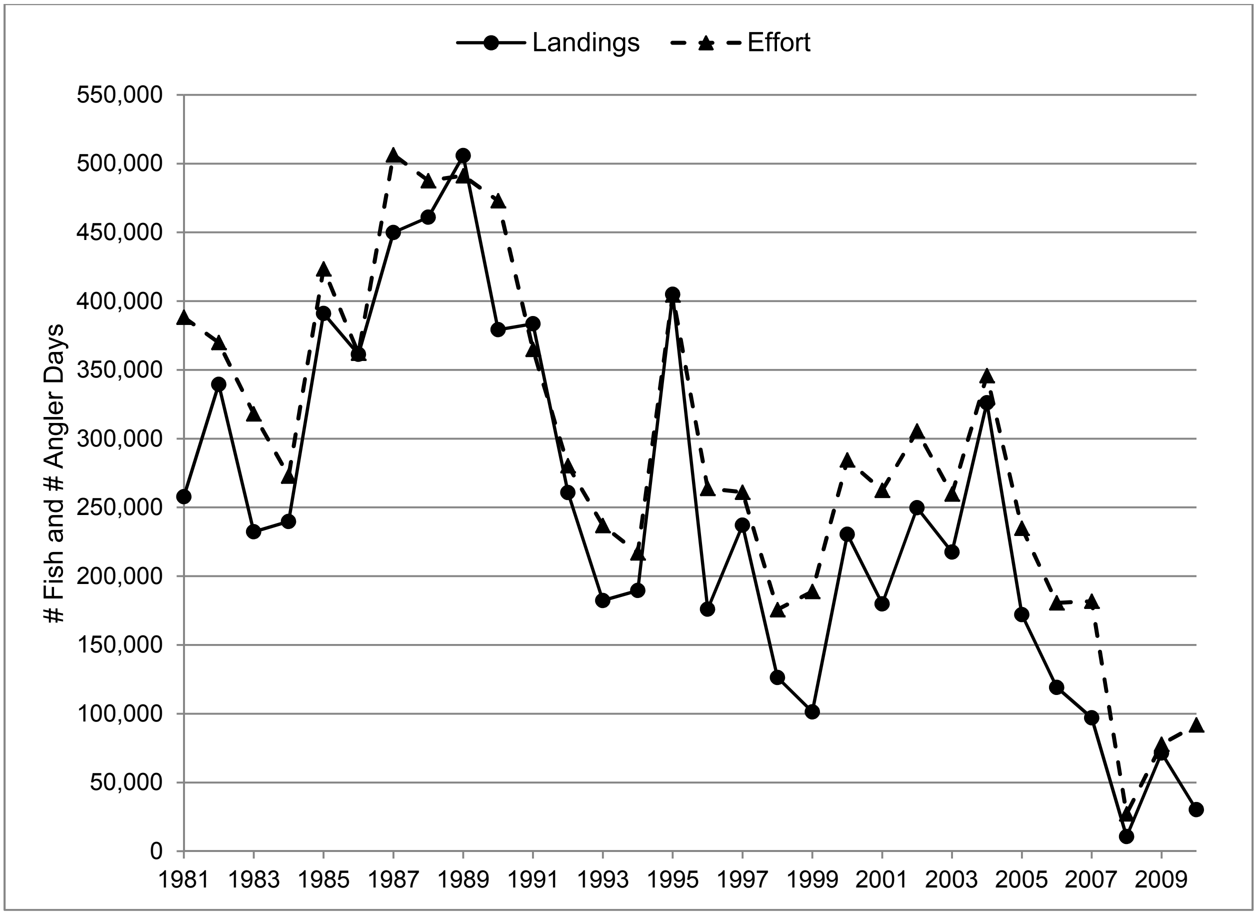

Figure II-2. Ocean recreational harvest (Chinook+coho, numbers of fish) and effort south of Cape Falcon, Oregon, 1981-2010 (sources: PFMC 1991, 1998, 2002, 2011b)

Figures II-3 and II-4 respectively reflect the differential effects of California and Oregon regulations on the ocean recreational fishery. During 1981-93, coho comprised a fairly modest 20 percent of California landings. Thus the prohibition on coho retention implemented in 1994 had a relatively moderate effect on the California fishery. The record low landings in the late 2000s are due to record low SRFC abundances, which lead to near-closure of the ocean recreational fishery in California during 2008-09 and very low harvests in 2010 (Figure II-3).

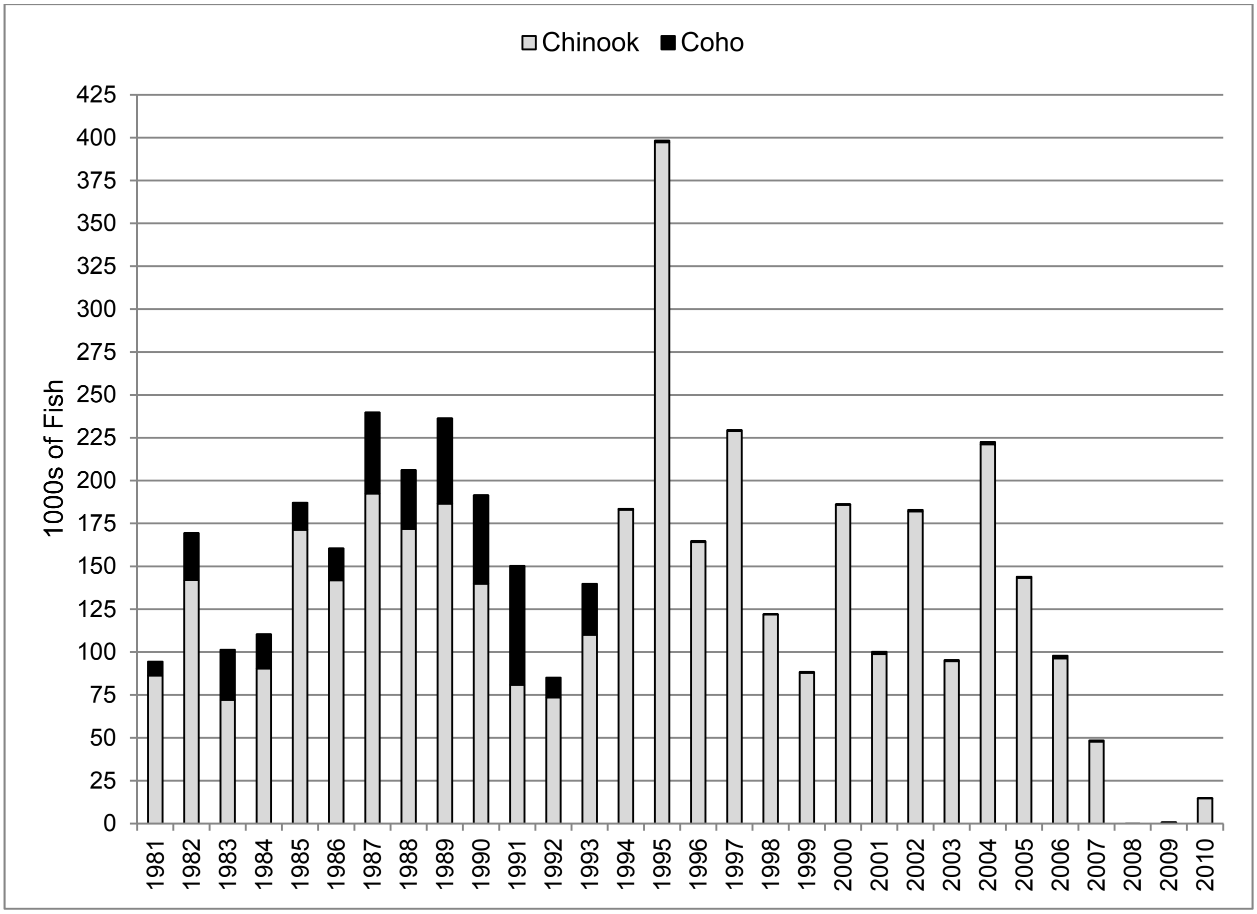

Figure II-3. Ocean recreational harvest (Chinook+coho, numbers of fish) in California, 1981-2010 (sources: PFMC 1991, 1998, 2011b).

The 1994 prohibition on coho retention had a greater effect in Oregon, where coho comprised 86 percent of total landings during 1981-93. The coho mark-selective fishery established by Oregon in 1999 provided some opportunity for recreational harvest, although landings remain at lower levels than experienced during the 1980s and early 1990s. Record low SRFC abundances during the late 2000s had a depressing influence on recreational Chinook harvests in all areas south of Cape Falcon; however, Oregon's mark-selective coho fishery continued to provide some recreational opportunity in those years (Figure II-4).

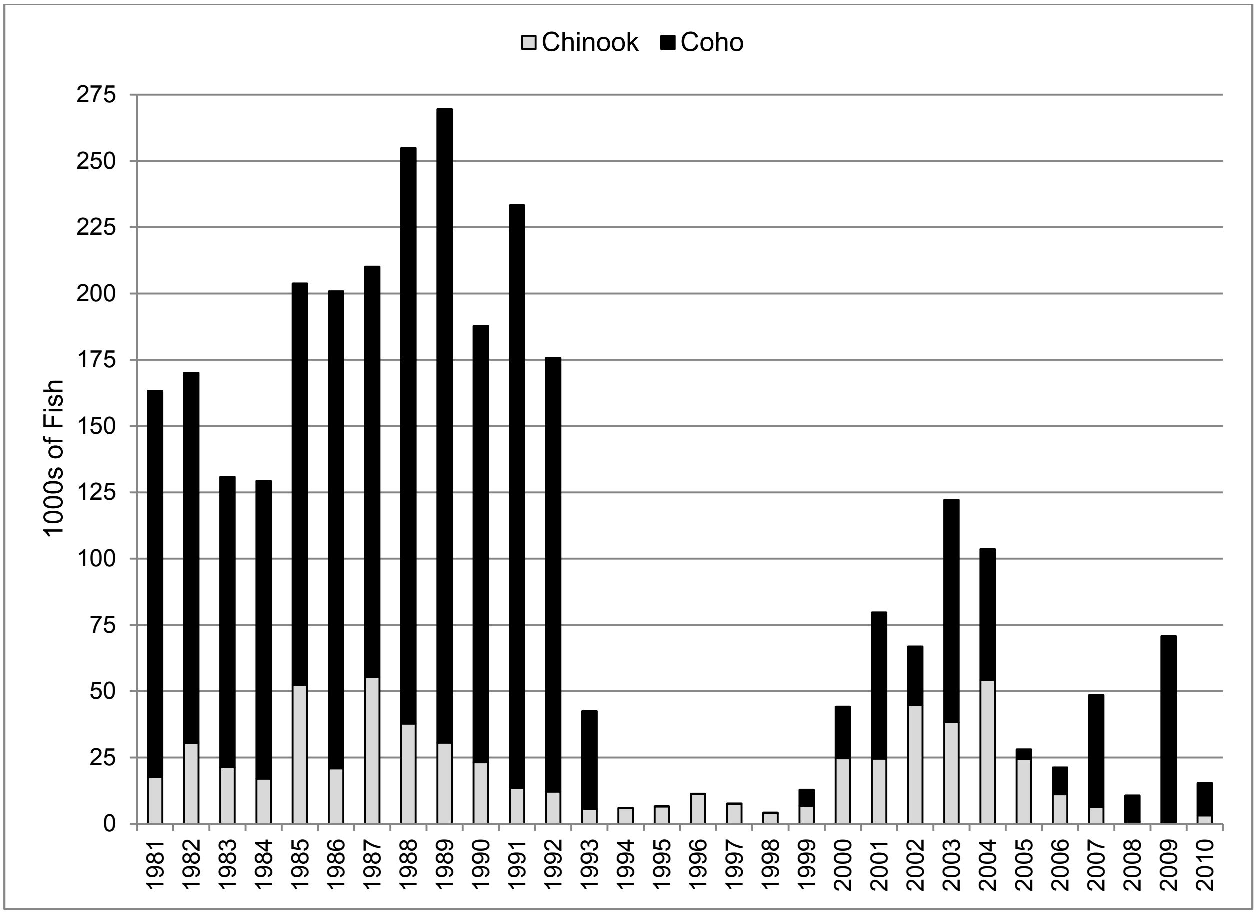

Figure II-4. Ocean recreational harvest (Chinook+coho, numbers of fish) in Oregon south of Cape Falcon, 1981-2010 (sources: PFMC 1991, 1998, 2011b).

Table II-1 describes the extent of coho dependence by management area during 1981-93 (prior to the prohibition on coho retention), 1994-98 (when coho retention was prohibited in both states), 1999-2005 (when the coho prohibition continued in California but was replaced by a mark-selective fishery in Oregon), and 2006-10 (when coho regulations were similar to 1999-05 but Chinook abundances fell to record low levels) .[4] Coho dependence has been consistently low in Monterey and San Francisco in all years. Coho dependence in Fort Bragg and KMZ-CA was 38 percent and 59 percent respectively during 1981-93, but has been very low thereafter due to California's ongoing prohibition on coho retention. In KMZ-OR, coho dependence was 52 percent during 1981-93 but has been consistently low during 1984-2005 (even after establishment of Oregon's mark-selective fishery); the increase in coho dependence to 44 percent after 2005 is largely due to the decline in Chinook harvest opportunity. During 1981-93, coho dependence in Central and Northern Oregon was 89 percent and 95 percent respectively, fell to less than five percent during the prohibition on coho retention (1994-98), then increased appreciably during 1999-2005 (after establishment of the mark selective fishery). The recent increase in coho dependence during 2006-10 (to 84 percent and 86 percent respectively), while

[4] The years 2006-10 are not included in the table, as the extent of coho dependence was masked in those years by record-low escapements of KRFC and SRFC.

comparable to the level of coho dependence during 1981-93, is due to the decline in Chinook abundance rather than an increase in coho harvest opportunity.

Table II-1. Average annual recreational coho landings during 1981-93, 1994-98, 1999-05 and 2006-10, by management area

	1981-1993		*1994-1998*		*1999-2005*		*2006-2010*	
Management Area	*Coho (# Fish)*	*% Total Salmon*	*Coho (# Fish)*	*% Total Salmon*	*Coho (# Fish)*	*% Total Salmon*	*Coho (# Fish)*	*% Total Salmon*
Monterey	497	2%	8	0%	97	0%	155[2]	2%[2]
San Francisco	1,962	3%	136	0%	309	1%	315[2]	1%[2]
Fort Bragg	4,300	38%	219	1%	204	1%	146[2]	1%[2]
KMZ-CA	25,092	59%	184	2%	237	2%	176[3]	3%[3]
KMZ-OR	14,323	52%	74	2%	246	3%	1,128	44%
Central OR	59,185	89%	34[1]	5%[1]	9,499	39%	6,186	84%
Northern OR	82,969	95%	31	2%	24,514	64%	21,624	86%

Sources: PFMC 1991, 1998, 2011b.

[1] Represents 1995-98 average, as the recreational fishery in Central Oregon was closed in 1994.

[2] Represents average of 2006, 2007 and 2010, as the recreational fishery in Monterey, San Francisco and Fort Bragg was closed in 2008-09.

[3] Represents average of 2006, 2007, 2009 and 2010, as the recreational fishery in KMZ-CA was closed in 2008.

Tables II-2 and II-3 summarize trends in ocean recreational landings and effort (angler days) by management area. Prior to the late 2000s, landings and effort have generally been higher in San Francisco than elsewhere. As indicated above, KRFC is usually the constraining stock for the ocean recreational fishery in KMZ-CA and KMZ-OR; concerns regarding KRFC are largely responsible for the landings decline in those areas between the 1980s and 1990s. In Central and Northern Oregon, effects of coho non-retention during 1994-98 and the subsequent mark-selective fishery are reflected in the landings decline during 1996-00 and the subsequent upsurge during 2001-05. Effects of the 2006 conservation concern for KRFC were felt in all areas. Record low SRFC abundance in the late 2000s resulted in record low landings and effort in all areas except Central and Northern Oregon, where the effect of low SRFC was buffered by continued coho harvest opportunity.

Table II-2. Ocean recreational Chinook and coho landings (# fish) during 1981-2010, by management area.

	Management Area							
Year(s)	*Monterey*	*San Fran*	*Ft Bragg*	*KMZ-CA*	*KMZ-OR*	*CentralOR*	*NorthOR*	*Total*
81-85Avg	6,720	86,800	4,380	34,680	28,460	60,420	70,620	292,080
86-90Avg	30,400	99,960	10,800	65,680	37,660	74,080	112,860	431,440
91-95Avg	58,260	93,460	18,620	21,060	10,840	37,840	44,140	284,220
96-00Avg	52,345	82,804	14,414	8,631	6,178	3,961	5,913	174,245
01-05Avg	31,408	77,653	24,008	15,885	7,349	27,255	45,485	229,043
06-10Avg	4,809	15,719	4,378	7,479	2,356	7,655	23,316	65,711
2001	20,256	40,345	26,501	13,010	7,277	28,849	43,613	179,851
2002	47,729	87,308	31,409	16,426	10,042	24,817	32,001	249,732
2003	13,286	56,823	16,289	8,889	5,499	39,125	77,588	217,499
2004	44,863	130,690	23,581	23,404	8,112	30,880	64,595	326,125
2005	30,905	73,097	22,259	17,695	5,817	12,606	9,627	172,006
2006	11,308	55,598	14,368	16,644	2,473	8,783	9,989	119,163
2007	6,381	17,000	5,772	19,297	4,619	14,150	29,834	97,053
2008	0	0	6	0	2,414	3,738	4,503	10,661
2009	0	0	0	680	1,392	9,979	59,417	71,468
2010	6,356	5,995	1,743	774	884	1,623	12,835	30,210

Sources: PFMC 1991, 1998, 2011b.

Table II-3. Ocean recreational salmon effort (# angler days) during 1981-2010, by management area.

	Management Area							
Year(s)	*Monterey*	*San Fran*	*Ft Bragg*	*KMZ-CA*	*KMZ-OR*	*CentralOR*	*NorthOR*	*Total*
81-85Avg	12,220	78,920	9,560	46,260	56,260	63,720	87,560	354,500
86-90Avg	49,180	98,580	15,420	77,500	58,380	61,360	103,640	464,060
91-95Avg	71,240	92,800	20,360	29,100	22,720	25,960	38,520	300,700
96-00Avg	63,020	94,000	19,140	18,540	18,360	8,260	13,480	234,800
01-05Avg	47,340	83,560	28,220	21,000	18,300	34,520	48,760	281,700
06-10Avg	14,320	24,700	9,040	9,300	7,720	14,120	32,660	111,860
2001	38,100	71,500	30,800	24,700	26,100	31,100	40,100	262,400
2002	67,900	88,800	31,800	21,600	19,700	33,400	42,400	305,600
2003	28,500	66,600	23,700	15,800	14,800	42,900	67,500	259,800
2004	56,500	106,100	30,500	25,600	18,300	40,500	68,300	345,800
2005	45,700	84,800	24,300	17,300	12,600	24,700	25,500	234,900
2006	27,700	61,300	21,000	16,400	10,700	17,200	26,300	180,600
2007	25,200	43,100	17,100	20,500	11,100	22,900	41,900	181,800
2008	0	0	400	0	4,800	7,400	14,600	27,200
2009	0	0	0	5,400	6,000	14,400	52,000	77,800
2010	18,700	19,100	6,700	4,200	6,000	8,700	28,500	91,900

Sources: PFMC 1998, 2002, 2011b.

III. Biological Assumptions

The economic effects of the no action and action alternatives on the ocean recreational fishery are largely driven by the effects on fish populations. This section discusses the biological effects of the alternatives on the SONCC coho ESU and Klamath River fall and spring Chinook.

III.A. SONCC Coho

The status of SONCC coho is discussed here in the context of NMFS' viability criteria and conclusions of the Biological Subgroup for the Secretarial Determination and an Expert Panel convened in December 2010 to evaluate the effects of the alternatives on steelhead and SONCC coho.

The SONCC coho ESU consists of 28 coho population units that range from the Elk and Rogue Rivers in southern Oregon to the Eel River in Northern California, including the coho populations in the Klamath Basin. NMFS' framework for assessing the biological viability of the SONCC coho ESU involves categorization of these component populations into seven diversity strata that reflect the environmental and genetic diversity across the ESU. Risk of extinction is evaluated on the basis of measurable criteria that reflect the biological viability of individual populations, the extent of hatchery influence, and the diversity and spatial structure of population units both within and across diversity strata (Williams *et al*. 2008).

The Klamath diversity stratum includes five population units, three of which (Upper Klamath, Shasta, Scott) are potentially affected by the action alternatives. According to the Biological Subgroup, "None of the population units of Klamath River coho salmon is considered viable at this point in time" (Biological Subgroup 2011, p 89) and "…all five of these Population Units have a high risk of extinction under current conditions" (Biological Subgroup 2011, p 90).

According to the Coho/Steelhead Expert Panel, adverse effects of dam removal on coho would likely be short-lived:

> "The short-term effects of the sediment release … will be injurious to upstream migrants of both species [coho and steelhead]…. However, these high sediment concentrations are expected to occur for periods of a few months in the first two years after the beginning of reservoir lowering and sediment flushing. For a few years after that period, suspended sediment concentrations are expected to be higher than normal, especially in high flow conditions, but not injurious to fish (Dunne *et al*. 2011, pp 18-19).

The Expert Panel noted the likely continuation of poor coho conditions under the no action alternative and a modest to moderate response of coho under the action alternatives (the moderate response being contingent on successful KBRA implementation):

> "Although Current Conditions will likely continue to be detrimental to coho, the difference between the Proposed Action and Current Conditions is expected to be small, especially in the short term (0-10 years after dam removal). Larger (moderate) responses are possible under the Proposed Action if the KBRA is fully and effectively implemented and mortality caused by the pathogen *C. shasta* is reduced. The more likely small response will result from modest increases in habitat area usable by coho with dam removal, small changes in

conditions in the mainstem, positive but unquantified changes in tributary habitats where most coho spawn and rear, and the potential risk for disease and low ocean survival to offset gains in production in the new habitat. Very low present population levels and low demographic rates indicate that large improvements are needed to result in moderate responses. The high uncertainty in each of the many individual steps involved for improved survival of coho over their life cycle under the Proposed Action results in a low likelihood of moderate or larger responses….Nevertheless, colonization of the Project Reach between Keno and Iron Gate Dams by coho would likely lead to a small increase in abundance and spatial distribution of the ESU, which are key factors used by NMFS to assess viability of the ESU" (Dunne *et al*. 2011, p ii).

The Biological Subgroup also notes the benefits of the action alternatives on coho viability:

> "Reestablishing access to historically available habitat above IGD will benefit recovery of coho salmon by providing opportunities for the local population and the ESU to meet the various measures used to assess viability (e.g., abundance, productivity, diversity, and spatial structure (Williams et al., 2006). Thus there would be less risk of extinction when more habitat is available across the ESU" (Biological Subgroup 2011, p 92).

The action alternatives are expected to improve the viability of coho populations in the Klamath Basin and advance the recovery of the SONCC coho ESU. However, since the action alternatives do not include coho restoration actions outside the Klamath Basin, they alone will not bring about the conditions that would warrant de-listing of the SONCC coho ESU throughout the species range. The potential for coho harvest under the no action and action alternatives is evaluated in the context of this conclusion.

III.B. Klamath River Spring and Fall Chinook

Biological effects of the no action and action alternatives on Klamath River Chinook are evaluated on the basis of two models – the Evaluation of Dam Removal and Restoration of Anadromy Model (Hendrix 2011) and a habitat-based model (Lindley and Davis 2011) – and conclusions of the Biological Subgroup (Hamilton *et al*. 2011) and an Expert Panel convened in January 2011 to evaluate the effects of the alternatives on Klamath River Chinook (Goodman *et al*. 2011).

III.B.1. Evaluation of Dam Removal and Restoration of Anadromy (EDRRA) Model

The Evaluation of Dam Removal and Restoration of Anadromy (EDRRA) model (Hendrix 2011) is a simulation model that provides 50-year projections of Klamath Chinook escapement, as well as separate harvest projections for the ocean recreational, inriver recreational, ocean troll and tribal fisheries under the no action alternative and dam removal alternatives (denoted as NAA and DRA respectively by Hendrix). Projections from the EDRRA model begin in 2012 (the year of the Secretarial Determination) and span the period 2012-61. The harvest projections for the DRA reflect the following assumptions: (i) active introduction of Chinook fry to the Upper Basin beginning in 2011, (ii) short-term effects on Chinook of sedimentation associated with

dam removal, (iii) gains in the quantity and quality of salmonid habitat associated with dam removal and KBRA, and (iv) loss of Iron Gate as a production hatchery in 2028.
The 50-year escapement and harvest projections provided by the model were each iterated 1000 times to capture the influence of uncertainties in model inputs on model outputs. The harvest projections pertain to Klamath/Trinity River Chinook and do not distinguish between spring and fall runs. Klamath/Trinity Chinook harvest (all fisheries combined) is estimated for each simulated year on the basis of the KRFC harvest control rule recommended by the PFMC to NMFS in June 2011 as part of a pending amendment to the Pacific Salmon FMP (Figure III-1). As an added constraint, the model also caps the forecast harvest rate for age-4 KRFC in the ocean fishery at 16 percent to address the consultation standard for California Coastal Chinook (listed as 'threatened' in 1999 – see Appendix A).

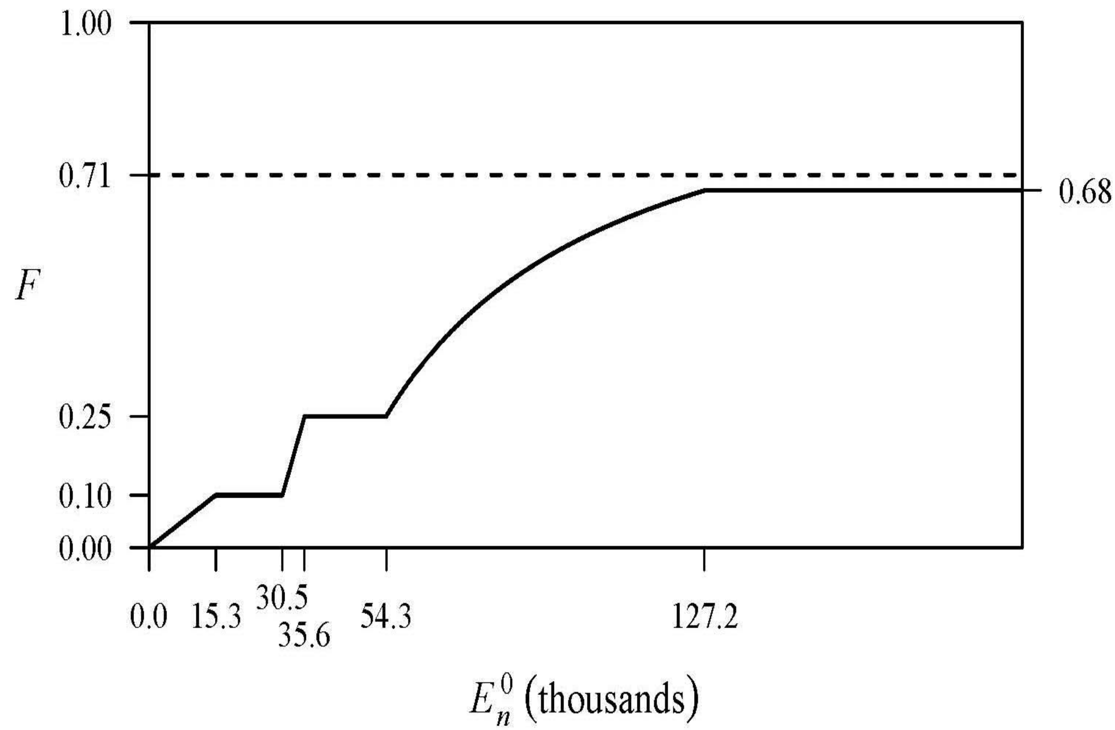

Figure III-1. Harvest control rule used in the EDRRA model (E_n^0 = annual escapement to natural areas prior to ocean and inriver harvest, F = harvest rate) (graphic by Michael Mohr, NMFS).

As reflected in Mohr (in prep) and consistent with PFMC practice, the model distributes the allowable harvest among fisheries as follows: 8.5 percent to the ocean recreational fishery, 7.5 percent to the inriver recreational fishery (up to a maximum of 25,000 fish – with any surplus above 25,000 allocated to escapement), 34.0 percent to the ocean commercial fishery, and 50.0 percent to tribal fisheries. The 50 percent tribal share is a 'hard' allocation specified by the Department of the Interior (USDOI 1993) on behalf of the Yurok and Hoopa Valley Tribes. The distribution of the remaining 50.0 percent among the three non-tribal fisheries represents customary practice rather than mandatory conditions (Appendix A).

Table III-1 summarizes model results for the entire 50-year projection period (2012-61) and for the following subperiods: (i) 2012-20 (pre-dam removal, hatchery influence); (ii) 2021-32 (post-dam removal, continued hatchery influence), and (iii) 2033-61 (post-dam removal, no hatchery influence).[5]

Table III-1. EDRRA model results for the ocean recreational fishery under the no action alternative (NAA) and dam removal alternative (DRA)

	Time Period			
Model Results	*2012-61*	*2012-20*	*2021-32*	*2033-61*
50th percentile harvest: % diff between NAA and DRA[1]	+43%	+7%	+60%	+47%
5th percentile harvest: % diff between NAA and DRA[1]	-57%	-77%	-46%	-55%
95th percentile harvest: % diff between NAA and DRA[1]	+725%	+421%	+821%	+780%
Average # years when DRA harvest > NAA harvest: % diff between NAA and DRA[2]	70%	54%	78%	71%
Average # years when pre-harvest adult natural spawning escapement ≤ 30,500: % diff between NAA and DRA[3]	-66%	-4%	-79%	-80%

[1] Source: EDRRA model outputs provided by Hendrix (2011). Derivation provided in Appendix B.1.b.
[2] Derivation provided in Appendix B.3.
[3] Derivation provided in Appendix B.4.
2012-61: 50-year projection period
2012-20: pre-dam removal
2021-32: post-dam removal, hatchery influence
2033-61: post-dam removal, no hatchery influence

The EDRRA model assumes that ocean abundance is known without error and that the harvest control rule exactly achieves the escapement objective (Hendrix 2011). Given that the absolute harvest projections provided by the model are an idealized version of real world conditions, model results are best considered in terms of relative rather than absolute differences between alternatives. The average percent difference between EDRRA's 50th percentile harvest projections for the NAA and DRA is +43 percent for the ocean recreational fishery. The annual increase varies by subperiod, with harvest increasing by +7 percent prior to dam removal (2012-2020), peaking at +60 percent during the 12 years after dam removal when the fishery is still influenced by hatchery production (2021-32), then diminishing somewhat to +47 percent during 2033-61 after hatchery influence dissipates in 2032 (Table III-1).

EDRRA model results indicate that the 5th percentile harvest value for the DRA is 57 percent lower than the 5th percentile value for the NAA and that the 95th percentile harvest value is 725 percent higher; that is, the DRA harvest distribution is positively skewed and exhibits a high degree of overlap with the NAA harvest distribution. The EDRRA model also provides information regarding the percent of simulated years in which DRA harvest exceeds NAA harvest (50 percent indicating no difference between the two alternatives). These paired comparisons were made possible by applying the parameter draws associated with each iteration of the simulation to both the NAA and DRA. The results in Table III-1 indicate virtually no

[5] The model assumes that Iron Gate would cease to operate as a production hatchery in 2028. Hatchery influence on the fishery would continue for another 3-4 years (the length of the life cycle of the last year class released from the hatchery).

difference between the alternatives during 2012-20 (54 percent) but higher harvests under DRA in the two subsequent subperiods (2021-32 and 2033-61) in a notable majority of years (78 percent and 71 percent respectively).

The harvest control rule incorporated into the EDRRA model (Figure III-1) limits the harvest rate to 10 percent or less when pre-harvest escapements fall below 30,500 adult natural spawners. Escapements this low would likely be accompanied by major regulatory restrictions and adverse economic conditions for the fishery. Such conditions occur in 66 percent fewer years under the DRA than the NAA – with the greatest declines (-79 percent during 2021-32, -80 percent during 2033-61) occurring in the post-dam removal years (Table III-1).

III.B.2. Biological Subgroup

According to the Biological Subgroup, the action alternatives are expected to provide habitat favorable to spring Chinook:

> "If dams were removed it is reasonable to expect reestablished spring-run Chinook salmon to synchronize their upstream migration with more natural flows and temperatures. The removal of Project reservoirs would also contribute important coldwater tributaries (e.g., Fall Creek, Shovel Creek) and springs, such as the coldwater inflow to the J.C. Boyle Bypassed Reach, to directly enter and flow unobstructed down the mainstem Klamath River, thereby providing thermal diversity in the river in the form of intermittently spaced patches of thermal refugia. These refugia would be useful to migrating adult spring-run Chinook salmon by extending opportunities to migrate later in the season. The thermal diversity would also benefit juvenile salmon" (Hamilton *et al*. 2011, p 87).

III.B.3. Lindley/Davis Habitat Model

The Lindley/Davis habitat model focuses on potential Chinook escapement to the Upper Basin above Iron Gate Dam (IGD). The analytical approach involved compilation of escapement and watershed attribute data for 77 fall and spring Chinook populations in various watersheds in Washington, Oregon, Idaho and Northern California, and comparison of those attribute sets with the attributes of Upper Basin watersheds. Based on their analysis, the authors concluded that Upper Basin attributes fall well within the range of spring bearing watersheds.
According to Lindley and Davis:

> "Our model predicts a fairly modest increase in escapement of Chinook salmon to the Klamath basin if the dams are removed. The addition of several populations of spring-run Chinook salmon with greater than 800 spawners per year to the upper Klamath would significantly benefit Klamath Chinook salmon from a conservation perspective, in addition to the fishery benefits….The last status review of the UKTR [Upper Klamath and Trinity Rivers] ESU expressed significant concern about the very poor status of the spring-run component of the ESU (Myers *et al*. 1998). Viable populations of spring-run Chinook salmon in the upper Klamath would increase the diversity and improve the spatial structure of the ESU, enhancing its viability (McElhaney *et al*., 2000) and improving the sustainability of the ESU into the uncertain future" (Lindley and Davis 2011, p 13).

III.B.4. Chinook Expert Panel

The Chinook Expert Panel concluded that "The Proposed Action offers greater potential for increased harvest and escapement of Klamath Chinook salmon than the Current Conditions" (Goodman *et al*. 2011, p 16). More specifically, the Panel noted that

> "…a substantial increase[6] in Chinook salmon is possible in the reach between Iron Gate Dam and Keno Dam. A modest or substantial increase in Chinook upstream of Keno Dam is less certain. Within the range of pertinent uncertainties, it is possible that the increase in Chinook salmon upstream of Keno Dam could be large, but the nature of the uncertainties precludes attaching a probability to the prediction by the methods and information available to the Panel. The principal uncertainties fall into four classes: the wide range of variability in salmon runs in near-pristine systems, lack of detail and specificity about KBRA, uncertainty about an institutional framework for implementing KBRA in an adaptive fashion, and outstanding ecological uncertainties in the Klamath system that appear not to have been resolved by the available studies to date" (Goodman *et al*. 2011, p 7).

With regard to spring Chinook, the Panel noted:

> "The prospects for the Proposed Action to provide a substantial positive effect for spring Chinook salmon is much more remote than for fall Chinook. The present abundance of spring Chinook salmon is exceptionally low and spawning occurs in only a few tributaries in the basin. Under the Proposed Action, the low abundance and productivity (return per spawner) of spring Chinook salmon will still limit recolonization of habitats upstream of IGD. Intervention would be needed to establish populations in the new habitats, at least initially. Harvests of spring Chinook salmon could occur only if spring Chinook salmon in new and old habitats survive at higher rates than at present. Therefore, habitat quality would need to be higher than at present, and KBRA actions would need to greatly improve survival of existing populations of spring Chinook salmon. Factors specifically affecting the survival of spring Chinook salmon have not been quantified" (Goodman *et al*. 2011, p 25).

IV. Ocean Recreational Fishing Economic Value for Benefit-Cost Analysis (NED Account)

IV.A. Methodology and Assumptions

The economic analysis provided here assumes that the ocean recreational fishery will continue to be constrained by consultation standards associated with ESA listings and that KRFC will continue to be a binding constraint on recreational harvest in the KMZ. This has been the case in

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[6] The Panel defined the term 'substantial increase' to mean 'a number of fish that contributes more than a trivial amount to the population' and cited 10 percent of the average number of natural spawners or 10,000 fish as a rough approximation to what they mean by 'substantial'. As indicated in their report, "The Panel does not suggest that this figure is a likely increase or a minimum increase that is expected. It is only used as a benchmark for our discussions and to provide a basis for interpreting our response to the question" (Goodman *et al*. 2011, p 7, footnote 3).

most years since the PFMC initiated its weak stock management policy in the early 1990s. Notable exceptions occurred in the late 2000s, when abundance of SRFC fell to record low levels and SRFC became the binding constraint on the recreational fishery not only in the KMZ but in almost all management areas. However, as indicated in Appendix A, it is not clear whether such low SRFC abundances signal a future pattern of persistent low abundances, are part of a cyclical pattern of downward and upward swings, or are events that may recur on a rare or occasional basis.

IV.A.1. SONCC Coho

As indicated in Section II.A, the SONCC coho ESU is listed as 'threatened' under the ESA. This ESU includes coho populations both inside and outside the Klamath Basin. The action alternatives are expected to increase the viability of Klamath River coho populations and advance recovery of the ESU (Hamilton *et al*. 2011, Dunne *et al*. 2011). However, since the action alternatives do not include coho restoration outside the Klamath Basin, they alone will not create conditions that would warrant de-listing of the SONCC coho ESU throughout its range. Thus, while they are expected to provide long term, positive biological effects, the action alternatives are not likely to affect the availability of coho to the ocean recreational fishery.

IV.A.2. Klamath River Spring and Fall Chinook

The EDRRA model (Hendrix 2011) is the basis for the quantitative projections of harvest, effort and economic value used to compare the no action and action alternatives. These variables were estimated as follows:[7]

(i) As indicated in Section III.B.1, the absolute harvest projections provided by the EDRRA model reflect idealized rather than real world conditions. Thus model results are best considered in terms of relative rather than absolute differences between alternatives. To anchor EDRRA projections to the real world, average annual ocean recreational harvest of Klamath Chinook during 2001-05 (4,255 fish)(data source: Michael O'Farrell, NMFS) was used to characterize the no action alternative. Annual harvest under the DRA (6,075 fish) was estimated by scaling average 2001-05 harvest upward, based on the difference between EDRRA's 50th percentile harvest projections for the NAA and DRA (+43 percent, according toTable III-1). The years 2001-05 were selected as the base period for the following reasons: KRFC fell within a moderate range of abundance during those years (Figure A-3); abundance of SRFC (which is targeted along with KRFC in the ocean recreational fishery south of Cape Falcon) also fell within a moderate range (FigureA-4); and management constraints and policies that are likely to continue into the future – e.g., policies established in the 1990s to protect weaker stocks (including ESA-listed stocks), the 50-50 tribal/non-tribal harvest allocation – were well established by that time. Record low

[7] See Appendix B for more details regarding the methods and assumptions underlying the harvest, effort and net economic value projections for each alternative.

fishery conditions experienced after 2005 made those years unsuited for base period characterization.[8]

(ii) Harvest of Klamath River Chinook varies by management area due to factors such as the biological distribution of the stock and fishery regulations. To reflect the influence of these factors, annual average Klamath Chinook harvest projected under the no action and action alternatives was distributed among management areas, based on the relative geographic distribution of KRFC harvests experienced in the ocean recreational fishery during the 2001-05 base period (data source: Michael O'Farrell, NMFS).[9]

(iii) In KMZ-CA and KMZ-OR, KRFC is managed as a 'constraining stock'; that is, the amount of Chinook harvest (all stocks) made available to the ocean recreational fishery is contingent on the allowable harvest of KRFC. To estimate average annual Chinook harvest (all stocks) attributable to the availability of Klamath Chinook, average annual Klamath Chinook harvest projected for these areas under the no action and action alternatives was divided by an area-specific expansion factor – calculated as the average ratio of annual Chinook harvest (all stocks) to annual Klamath Chinook harvest during 2001-05 (data source: Michael O'Farrell, NMFS). In the remaining areas (Monterey, San Francisco, Fort Bragg, Central Oregon and Northern Oregon), Klamath Chinook is not a constraining stock except in years of very low Klamath Chinook abundance. For these latter areas, the expansion factor was set equal to 1.000 to reflect the fact that Klamath Chinook availability in these areas does not affect the recreational fishery's access to other stocks; thus Klamath Chinook harvest is treated as a simple addition to total harvest under the no action and action alternatives.[10]

(iv) Total Chinook harvest (all stocks) in each area attributable to the availability of Klamath Chinook was converted from numbers of fish to angler days by multiplying average annual number of fish projected for each area under the no action and action alternatives by an area-specific conversion factor – calculated as the average ratio of angler days to total Chinook harvest during 2001-05 (data source: PFMC 2011).[11]

(v) The net economic value (NEV) of the fishery was measured in terms of consumer surplus per angler day, derived from a travel cost model estimated with data collected in a 2000 survey of recreational anglers sponsored by NMFS.[12]

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[8] The decades prior to the 2000s were also deemed unsuitable for characterizing the no action alternative. The 1980s pre-date current weak stock management policies. The 1990s was a period of adjustment to constraints that are expected to continue into the future (e.g., consultation standards for ESA-listed stocks, 50-50 tribal/non-tribal allocation) and also includes years of unusually low landings.

[9] Distribution of ocean recreational harvest of KRFC during 2001-05 was as follows: Monterey 3.2 percent, San Francisco 12.1 percent, Fort Bragg 31.4 percent, KMZ-CA 20.3 percent, KMZ-OR 19.5 percent, Central Oregon 9.7 percent, Northern Oregon 4.0 percent.

[10] The expansion factors used in the analysis are as follows: Monterey 1.000, San Francisco 1.000, Fort Bragg 1.000, KMZ-CA 0.049, KMZ-OR 0.149, Central Oregon 1.000, Northern Oregon 1.000.

[11] The conversion factors used in the analysis are as follows: Monterey 1.649, San Francisco 1.194, Fort Bragg 1.215, KMZ-CA 1.435, KMZ-OR 2.641, Central Oregon 2.400, Northern Oregon 3.529.

[12] See Appendix C for details.

Harvest projections provided by the EDRRA model do not differentiate between spring and fall Chinook. However, actual harvest opportunities may differ somewhat by fishery – depending on the extent to which the harvestable surplus includes spring Chinook. The Biological Subgroup indicates that the action alternatives will result in expansion and restoration of habitat beneficial to spring Chinook. The Lindley/Davis model anticipates positive conservation benefits in terms of returning spring Chinook to Upper Basin watersheds and enhancing the viability of the Klamath/Trinity Chinook ESU, as well as modest fishery benefits. The Chinook Expert Panel indicates that a 'substantial increase' in Chinook between IGD and Keno Dam is possible but is more cautious regarding the possibility of successful Chinook introduction above Keno Dam and benefits to spring Chinook (Section III.B). The Biological Subgroup, Lindley/Davis and Expert Panel results are used here to qualify and expand on the EDRRA results by considering what the availability of modest amounts of spring Chinook in the harvestable surplus might mean for the ocean recreational fishery.

IV.B. Alternative 1 – No Action

IV.B.1. SONCC Coho

As indicated in Section II, the prohibition on coho retention in California's ocean recreational fishery since 1994 effectively meets the consultation standard for Central California Coast coho (listed in 1996); this prohibition also meets the consultation standard for SONCC coho (listed in 1997). Management of Oregon's mark-selective coho fishery includes a marked coho quota and season limits to ensure that the recreational fishery meets consultation standards for ESA-listed coho ESUs – including SONCC coho (PFMC 2011). Current coho fishery constraints in California and Oregon south of Cape Falcon are expected to continue into the future under Alternative 1.

IV.B.2. Klamath River Spring and Fall Chinook

Under Alternative 1, annual Klamath Chinook harvest is 4,255 fish and annual Chinook harvest (all stocks) attributable to the presence of Klamath Chinook is 25,707 fish. In KMZ-CA and KMZ-OR, total Chinook harvest (all stocks) is higher than Klamath Chinook harvest, due to the use of expansion factors to estimate total harvest of all stocks associated with the availability of Klamath Chinook. In the remaining areas (Monterey, San Francisco, Fort Bragg, Central Oregon and Northern Oregon), Klamath Chinook is not a constraining stock; that is, increases in Klamath Chinook harvest represent a simple addition to total harvest and do not yield benefits in terms of increased access to other stocks.[13] Average annual fishing effort under Alternative 1(all areas) is 43,955 angler days, with an associated NEV of $6.7M (Table IV-1).

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[13] It is important to note that total Chinook harvest (all stocks) and angler days reported in Table IV-1 pertain only to harvest and effort attributable to the availability of Klamath Chinook. Klamath Chinook is not normally a constraining stock (i.e., does not affect access to other stocks) in Monterey, San Francisco, Fort Bragg, Central Oregon and Northern Oregon. Thus recreational harvest and effort in those areas attributable to Klamath Chinook (Table IV-1) are much less than actual harvest and effort during the 2001-05 base period (Tables II-2 and II-3).

Table IV-1. Projected average annual ocean recreational harvest of Klamath Chinook and total Chinook (all stocks) attributable to Klamath Chinook abundance, and associated angler days and net economic value under Alternative 1 – by management area.[1]

Management Area	*# Klamath Chinook*	*# Chinook (All Stocks)*	*# Angler Days*	*Net Economic Value (2012$)*
Monterey	136	136	224	34,191
SanFran	514	514	614	93,527
FortBragg	1,334	1,334	1,621	246,969
KMZ-CA	862	17,585	25,234	3,844,933
KMZ-OR	828	5,557	14,675	2,236,014
CentralOR	411	411	987	150,429
NorthernOR	170	170	599	91,340
Total	4,255	25,707	43,955	6,697,401

[1] Calculations based on methodology discussed in Section IV.A.2.

Ocean recreational harvest of Klamath Chinook consists almost exclusively of fall run fish. This stock composition is expected to persist into the future under Alternative 1.

IV.C. Alternative 2 – Full Facilities Removal of Four Dams

IV.C.1. SONCC Coho

Alternative 2 is expected to improve the viability of coho populations in the Klamath stratum of the SONCC coho ESU, but is unlikely to lead to de-listing, since the ESU also includes stocks outside the Klamath Basin whose viability is not affected by this action (Section III.A). Thus under Alternative 2, California will likely continue its prohibition on coho harvest. Oregon's mark-selective recreational fishery will continue to be constrained by consultation standards for multiple ESA-listed coho ESUs, including SONCC coho.

IV.C.2. Klamath River Spring and Fall Chinook

IV.C.2.a. Effects on Annual Harvest, Effort and Net Economic Value

Under Alternative 2, annual average salmon harvest is projected to include 6,075 Klamath Chinook and 36,702 total Chinook (all stocks). In KMZ-CA and KMZ-OR, total Chinook harvest (all stocks) is higher than Klamath Chinook harvest, due to the use of expansion factors to estimate total harvest of all stocks attributable to the availability of Klamath Chinook in those areas. In the remaining areas (Monterey, San Francisco, Fort Bragg, Central Oregon and Northern Oregon), increases in Klamath Chinook harvest represent a simple addition to total harvest and do not yield benefits in terms of increased access to other stocks.[14] Total fishing

[14] It is important to note that total Chinook harvest (all stocks), fishing effort and net economic value reported in Table IV-2 pertain only to harvest, effort and value attributable to the availability of Klamath Chinook. Klamath Chinook is not normally a constraining stock (i.e., does not affect access to other stocks) in Monterey, San Francisco, Fort Bragg, Central Oregon and Northern Oregon. Thus recreational harvest, effort and value in those areas attributable to Klamath Chinook are likely much less than actual

effort (all areas) attributable to Klamath Chinook is 62,756 angler days, with an associated net economic value of $9.6 million. Average annual NEV is $2.9 million higher under Alternative 2 than Alternative 1 (Table IV-2).

Table IV-2. Projected average annual ocean recreational harvest of Klamath Chinook, total Chinook (all stocks) attributable to Klamath Chinook abundance, and fishing effort and net economic value under Alternative 2, and change in net economic value from Alternative 1 – by management area.

Management Area	*# Klamath Chinook*[1]	*# Chinook (All Stocks)*[1]	*# Angler Days*[1]	*Net Economic Value (2012$)*[1]	*Change in Net Economic Value*[2]
Monterey	194	194	320	48,815	14,624
SanFran	734	734	876	133,531	40,004
FortBragg	1,905	1,905	2,314	352,605	105,636
KMZ-CA	1,230	25,106	36,028	5,489,534	1,644,601
KMZ-OR	1,182	7,933	20,952	3,192,429	956,415
CentralOR	587	587	1,410	214,772	64,343
NorthernOR	243	243	856	130,409	39,069
Total	6,075	36,702	62,756	9,562,094	2,864,693

[1] Calculations based on methodology described in Section IV.A.2.
[2] Difference in net economic value between Alternative 2 (column 5 of this table) and Alternative 1 (column 5 of Table IV-1).

To the extent that spring Chinook production increases sufficiently to provide a harvestable surplus, the EDRRA projections (which include but do not distinguish between spring and fall Chinook) may over-estimate ocean recreational harvest. The reason for this has to do with the timing of the run relative to the timing of the fishery. For instance, the recreational season between Point Arena and Pigeon Point (San Francisco management area) does not open until the first Saturday in April in order to meet the consultation standard for ESA-listed Sacramento River winter Chinook (PFMC 2011). Given this season structure, the harvest potential of spring Chinook may be limited for the ocean recreational fishery, as a large portion of the spring run will have returned to the river by the time the season opens.

IV.C.2.b. Discounted Present Value of Change in Net Economic Value

Figure IV-1 depicts the annual trajectory of NEV for Alternatives 1 and 2 during 2012-61. These annual values were derived by multiplying average annual NEV (all areas) associated with each alternative (Tables IV-1 and IV-2 respectively) by an annual adjustment factor that reflects the variation in annual Klamath Chinook harvest relative to mean 2012-61 harvest – as projected by the EDRRA model (Appendix B.2). As indicated in Figure IV-1, the difference between the two alternatives diverges considerably after dam removal.

total harvest, effort and net economic value (all stocks) that would occur under the biological conditions projected for Alternative 2.

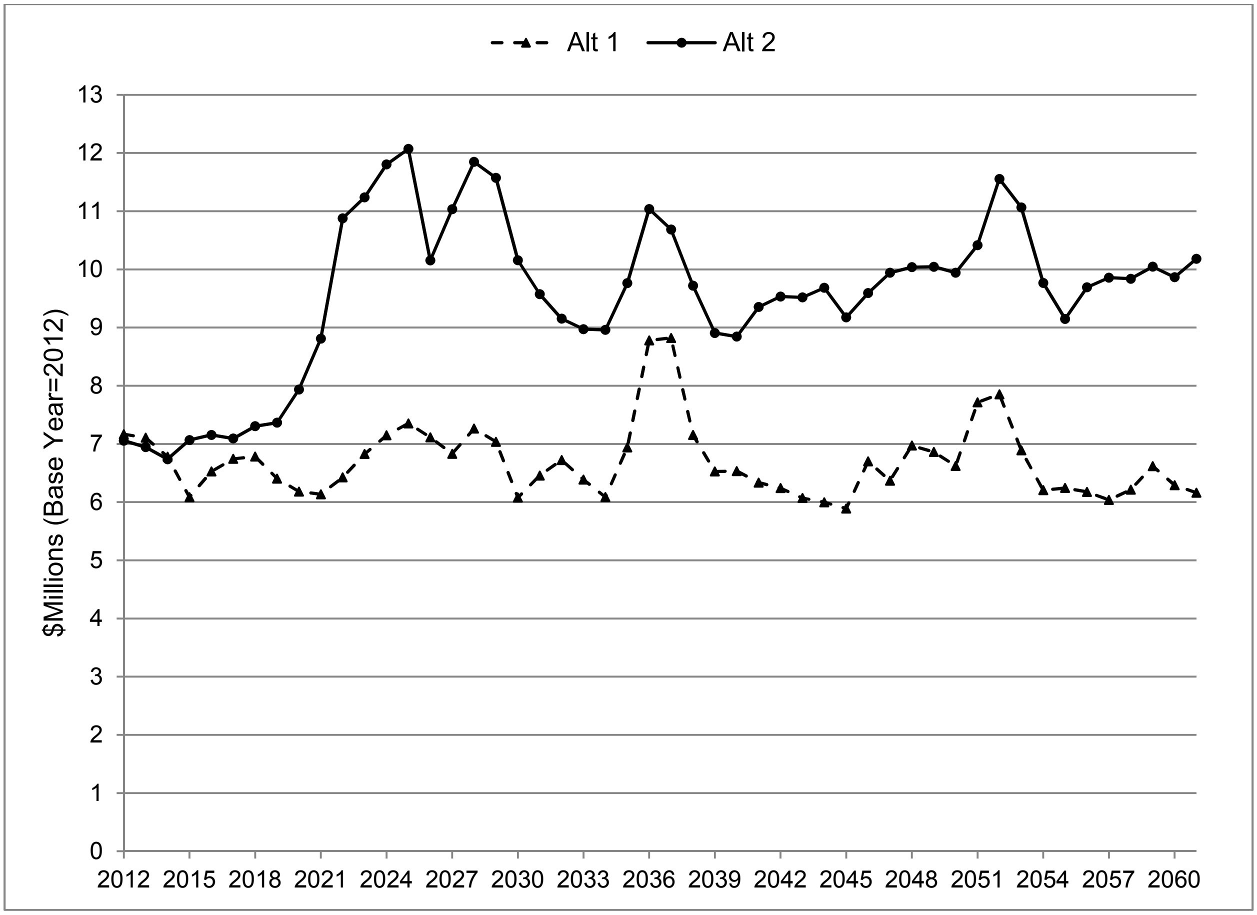

Figure IV-1. Projected annual net economic value under Alternatives 1 and 2, 2012-2061 (calculated according to the methodology described in Appendix B-2).

Results of the NED analysis provided here are also included in two summary reports (Reclamation 2011a, 2011b) that describe all quantifiable economic benefits and costs in terms of discounted present value (DPV). Discounting is based on the premise that benefits that occur more immediately are preferred to benefits that occur farther into the future. Discounting has the effect of attaching progressively smaller weights to changes in NEV that occur later in the time series, with diminution of these weights becoming more rapid at higher discount rates. The discount rate used in the NED analysis is 4.125 percent, the rate currently prescribed for Federal water resources planning (Reclamation 2010).

DPV for the ocean recreational fishery was calculated by applying a discount factor to each of the annual NEV estimates provided in Figure IV-1, then summing the results (Appendix B.2). Table IV-3 provides estimates of DPV associated with the prescribed 4.125 percent rate and several rates lower and higher than 4.125 percent (including 0.000 percent – no discounting). DPV associated with the 4.125 percent discount rate is $52.8 million, which is 37 percent of the undiscounted present value (discount rate of 0.000 percent) and twice the value of DPV associated with the 8.000 percent discount rate.

Table IV-3. Discounted present value of the increase in net economic value under Alternative 2 relative to Alternative 1 (2012$), calculated on the basis of alternative discount rates.

Discount Rate	*Discounted Present Value (2012$)*
0.000%	143,240,078
2.000%	85,081,565
4.125%	52,809,655
6.000%	36,665,193
8.000%	26,043,633

Calculations based on methodology described in Appendix B.2.

Figure IV-2 depicts the stream of the annual discounted increases in NEV that were summed to derive the DPV estimate associated with each of the discount rates in Table IV-3. As indicated in the figure, changes in NEV are relatively insensitive to the choice of discount rate in the first decade of the time series but can diverge rather widely in subsequent decades. The differences in the DPV estimates shown in Table IV-3 are influenced by the fact that changes in NEV under Alternative 2 do not increase appreciably until after dam removal, which does not occur until close to the end of the first decade of the projection period 2012-61.

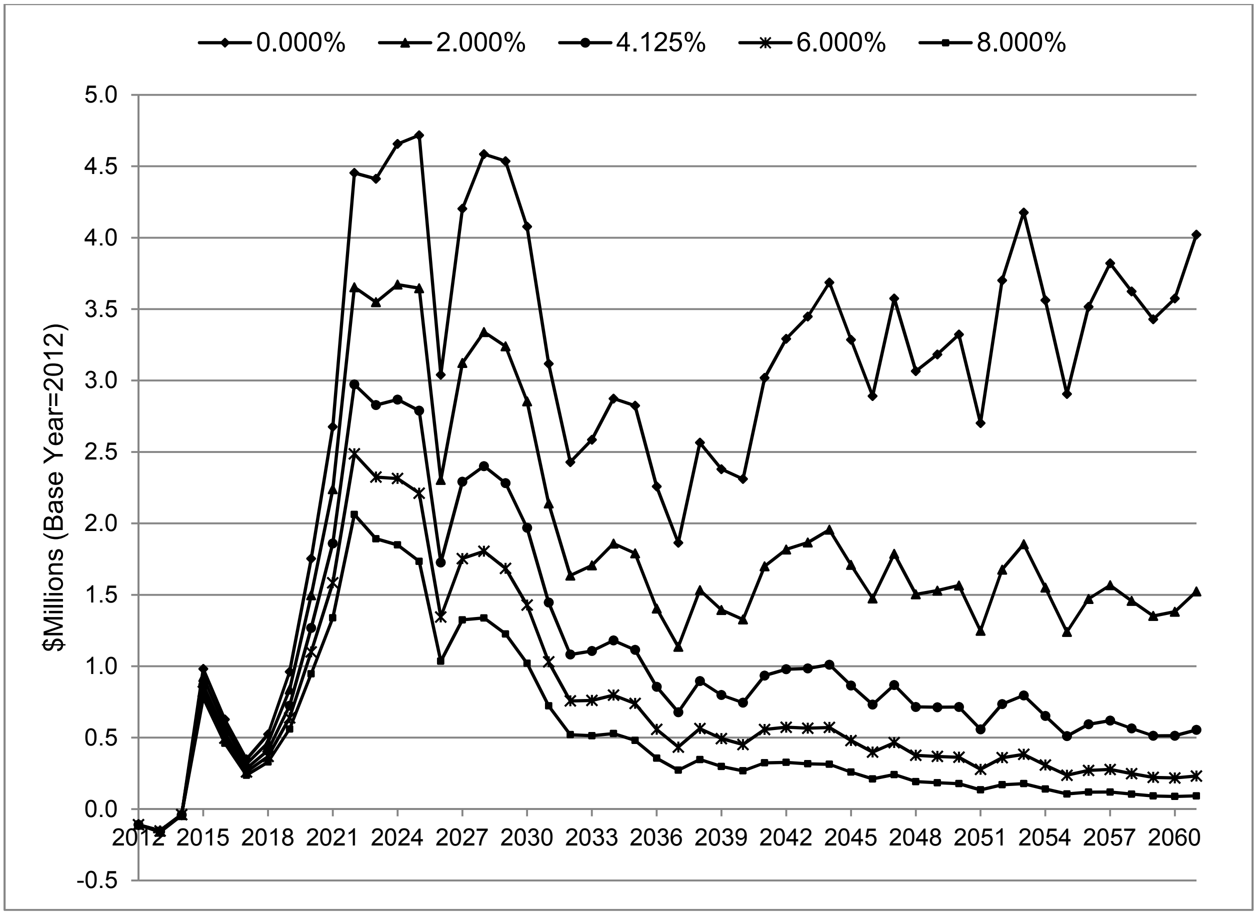

Figure IV-2. Annual discounted values of the increase in net economic value under Alternative 2 relative to Alternative 1 (2012$) during 2012-61, calculated using alternative discount rates of 0.000% (no discounting), 2.000%, 4.125%, 6.000%, and 8.000%.

IV.C.2.c. Effects at Low Levels of Abundance

Economic effects pertain not only to how harvest opportunity is affected on an average basis but also under more unusual conditions. As indicated in Figure III-1, the KRFC harvest control rule adopted by the PFMC in June 2011 limits the harvest rate to 10 percent or less when pre-harvest escapements fall below 30,500 adult natural spawners. Escapements this low would be accompanied by adverse economic conditions that are reminiscent of the situation in 2006, when actions to protect KRFC required major reductions in harvest of all salmon stocks in all areas south of Cape Falcon. This situation was unusual in that KRFC normally constrains recreational harvest of other stocks only in the KMZ. In 2006, salmon recreational landings and effort south of Cape Falcon fell to 52 percent and 64 percent respectively of their 2001-05 average values (Tables II-2 and II-3). Results of the EDRRA model indicate that pre-harvest escapements below 30,500 would occur in 66 percent fewer years under Alternative 2 than Alternative 1, with the greatest decline (-79 percent) occurring in the post-dam removal years (Table III-1). While the quantitative economic results provided in Sections IV.C.2.a and IV.C.2.b pertain to how the action alternatives would affect fishery conditions at moderate levels of abundance, it is important to note that Alternative 2 will also reduce the incidence of low abundances and associated adverse effects on the ocean recreational fishery.

IV.D. Alternative 3 – Partial Facilities Removal of Four Dams

Alternative 3 is intended to provide the same habitat conditions as Alternative 2 – i.e., fish passage unencumbered by dams and a free-flowing river, as well as benefits of the KBRA. Therefore the effects of this alternative on Chinook and coho populations and the ocean recreational fishery are expected to be the same as Alternative 2.

V. Ocean Recreational Fishing Expenditures for Regional Economic Impact Analysis (RED Account)

V.A. Methodology and Assumptions

Regional economic impacts pertain to effects of the no action and action alternatives on employment, labor income and output in the regional economy. These impacts include: direct effects on the economy as recreational anglers make expenditures on party/charter boat fees, fuel for private boats, gasoline, bait and tackle, food and lodging, and the like; indirect effects as payments by fishery support businesses to their vendors generate additional economic activity; and induced effects associated with changes in household spending by workers in all affected businesses. Estimation of this so-called multiplier effect is based on assumptions such as constant returns to scale, no input substitution, no supply constraints, and no price or wage adjustments. Thus regional impacts as estimated here are more suggestive of the economy's short-term response rather than long-term adjustment to infusions of money into the economy. Regional impacts were estimated using Impact Analysis for Planning (IMPLAN) software and data and are based on the makeup of the economy at the time of the underlying IMPLAN data (2009). The applicability of the impacts thus estimated to any particular year of the 50 year study period is affected by the extent to which the underlying economy in that year deviates from the economy in 2009. The employment impacts include full time, part time, and temporary positions. These impacts may not be fully realized to the extent that businesses deal with changes in demand by adjusting the workload of existing employees or increasing their use of capital relative to labor rather than hiring new employees.

The regional economic analysis provided here is based on average annual angler expenditures projected for the no action and action alternatives. About 91 percent of angler days attributable to the availability of Klamath Chinook is concentrated in two of the seven management areas under the no action and action alternatives (Tables IV-1 and IV-2 respectively). Thus the regional economic analysis focuses on those two areas: KMZ-CA (Humboldt and Del Norte Counties) and KMZ-OR (Curry County). Non-resident expenditures spent in the region and the multipliers used to estimate the impacts of these expenditures will vary, depending on how the affected region is defined. Thus regional impacts will differ, depending on whether they are (i) estimated separately for the two areas or (ii) estimated for a single study area defined as the aggregation of the two areas. Because the impacts provided here were estimated in the manner of (i), summing the impacts in KMZ-CA and KMZ-OR will not provide an accurate estimate of the impacts in both areas combined. More detailed documentation of the methods used to estimate regional impacts is provided in Reclamation (2011a).

A basic assumption underlying this regional impact analysis is that increases in expenditures by resident anglers associated with expanded fishing opportunities would be accommodated by reducing expenditures on other locally purchased goods and services – with no net change in local economic activity. For non-resident anglers, however, increases in local expenditures associated with increases in local fishing opportunities would be accomplished by diverting money that they would otherwise spend outside the local area. Thus the economic impact analysis focuses on non-resident angler expenditures, which represent 'new money' whose injection serves to stimulate the local economy.

Expenditures in KMZ-CA by anglers residing outside of KMZ-CA and expenditures in KMZ-OR by anglers residing outside of KMZ-OR provide the basis for the multiplier effects in these two areas. Non-resident expenditures were estimated for each area by multiplying the annual number of angler days attributable to non-residents by average non-resident expenditures per angler day. These variables were derived as follows:

- <u>Annual number of angler days in each mode by non-resident anglers:</u> Ocean recreational salmon fishing is largely boat-based, with effort occurring in two modes: party/charter boat and private boat. Table V-1 describes the relative distribution of salmon effort in KMZ-CA and KMZ-OR between party/charter and private boat modes

Table V-1. Distribution of angler days in KMZ-CA and KMZ-OR by fishing mode

Relative distribution of recreational angler days in KMZ-CA and KMZ-OR between fishing modes[1]		
Management Area	*Party/Charter*	*Private Boat*
KMZ-CA	.066	.934
KMZ-OR	.026	.974

[1] Estimates based on 2001-05 data (source: PFMC 2011).

Zipcode of residence data collected in creel surveys conducted by California Department of Game (CDFG) and Oregon Department of Fish and Wildlife (ODFW) were used to estimate the proportion of angler days in each mode and area attributable to non-resident anglers. The zipcode data used for KMZ-CA (both modes) were collected by CDFG during 2004-06. The zipcode data used for KMZ-OR were collected by ODFW during 1998-99 (party/charter mode) and 2000-02 (private boat mode).[15] Table V-2 describes the proportion of fishing effort in each mode and area attributable to non-resident anglers.

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[15] Zip code data collection has been more sporadic in Oregon and thus based on less recent data.

Table V-2. Proportion of party/charter and private boat recreational angler days in KMZ-CA and KMZ-OR attributable to non-resident anglers[1]

Management Area	*Party/Charter*	*Private Boat*
KMZ-CA	.515	.229
KMZ-OR	.924	.506

[1] Estimates based on zipcode data collected from intercept surveys conducted in KMZ-CA by CDFG during 2004-06, and zipcode data collected from intercept surveys conducted in KMZ-OR by ODFW during 1998-99 (party/charter mode) and 2000-02 (private boat mode).

The estimates of annual angler days in KMZ-CA and KMZ-OR used here for the no action and action alternatives are identical to and were derived in the same manner as the estimates used in the NED analysis: 25,234 in KMZ-CA and 14,675 in KMZ-OR for the no action alternative (Table IV-1), 36,028 in KMZ-CA and 20,952 in KMZ-OR for the action alternatives (Table IV-2). The number of angler days attributable to nonresident anglers under each alternative (which was not relevant to the NED analysis) was estimated by applying the modal proportions in Tables V-1 and the non-resident proportions in Table V-2 to the annual effort estimates for KMZ-CA and KMZ-OR.

- <u>Non-resident expenditures per angler day:</u> Average expenditures per angler day by non-resident anglers (for lodging, food, gasoline, fishing gear, party/charter boat fees, private boat fuel, equipment rental, access fees, and bait/ice) were estimated separately for each mode. These estimates were derived from data collected in a 2000 economic survey of saltwater anglers conducted by NMFS. In cases where a fishing trip involved multiple days and/or multiple anglers, expenditures per angler day were estimated by dividing total trip expenditures by the number of angler day equivalents associated with that trip. Costs in all expenditure categories were adjusted for inflation to 2012 dollars. The estimates thus derived are $203.93 for party/charter mode and $56.00 for private boat mode.

  To estimate the gasoline component of expenditures, the round-trip travel distance between each respondent's zipcode of residence and fishing site was estimated using PC Miler (specialized transportation software), then converted to distance per angler day by dividing by the number of angler days associated with the trip. Gasoline cost per angler day was estimated by multiplying miles traveled per angler day by fuel cost per mile, which was derived as follows: Estimates of fuel cost per mile during 2006-10 were obtained from the American Automobile Association (AAA 2006, 2007, 2008, 2009, 2010). To reflect the differential between gasoline prices in the Klamath Basin and prices assumed by the AAA in its estimates, the per-gallon price of fuel in Humboldt county during 2006-10 (data source: Erick Eschker, Humboldt Economic Index) was divided by AAA's assumed price for the same year, and the resulting ratio was multiplied by AAA's fuel cost per mile. These adjusted estimates of fuel cost per mile (reflecting the regional differential in fuel prices) were then corrected for inflation and averaged over the years 2006-10 – yielding a mean value of $0.147 per mile (2012$).[16]

V.B. Alternative 1 – No Action

Table V-3 provides estimates of total angler days, non-resident angler days, and non-resident expenditures in KMZ-CA and KMZ-OR under Alternative 1.

Table V-3. Estimated annual angler days, non-resident angler days and non-resident angler expenditures in KMZ-CA and KMZ-OR under Alternative 1.

	KMZ-CA	*KMZ-OR*
Total angler days:		
• Party/charter	1,665	382
• Private boat	23,569	14,293
• Total	25,234	14,675
Non-resident angler days:		
• Party/charter	1,539	196
• Private boat	11,926	3,273
• Total	13,465	3,469
Non-resident angler expenditures (2012$):		
• Party/charter	$313,824	$ 40,072
• Private boat	667,843	183,298
• Total	$981,668	$223,369

Total angler days in KMZ-CA and KMZ-OR under Alternative 1 obtained from Table IV-1. Breakdown of angler days between party/charter and private boat mode estimated from modal proportions provided in Table V-1. Number of angler days in each mode attributable to non-resident anglers estimated from non-resident proportions provided in Table V-2. Non-resident angler expenditures based on estimates of non-resident expenditure per angler day of $200.04 for party/charter mode and $54.66 for private boat mode (2012$).

[16] Gasoline prices are subject to considerable uncertainty over the 50-projection period. Changes in gasoline prices can have a notable influence on angler expenditures associated with travel to the recreational site, as well as the cost of other recreational goods and services whose prices are sensitive to changes in energy costs.

Table V-4 describes the impacts of Alternative 1 on employment, income and output in KMZ-CA and KMZ-OR. These impacts are based on non-resident expenditures of $981.7 thousand for KMZ-CA and $223.4 thousand for KMZ-OR (Table V-3).

Table V-4. Annual regional economic impacts of ocean recreational expenditures in KMZ-CA and KMZ-OR by non-resident anglers under Alternative 1.

KMZ-CA			
Impact Type	*Employment (Jobs)*	*Labor Income ($Millions)*	*Output ($Millions)*
Direct	9.4	0.28	0.71
Indirect	1.5	0.06	0.19
Induced	2.0	0.07	0.22
Total	**12.9**	**0.42**	**1.12**
KMZ-OR			
Impact Type	*Employment (Jobs)*	*Labor Income ($Millions)*	*Output ($Millions)*
Direct	2.3	0.06	0.15
Indirect	0.3	0.01	0.03
Induced	0.3	0.01	0.03
Total	**2.9**	**0.08**	**0.21**

Source: Reclamation 2011b, presented in 2012 dollars.
Employment measured in number of jobs. Labor income is dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals in the analysis area. Output represents dollar value of industry production.

V.C. Alternative 2 – Full Facilities Removal of Four Dams

Table V-5 provides estimates of the change in total angler days, non-resident angler days and non-resident expenditures in KMZ-CA and KMZ-OR from Alternative 1 to Alternative 2.

Table V-5. Estimated annual angler days, non-resident angler days and non-resident angler expenditures in KMZ-CA and KMZ-OR under Alternative 2, and change from Alternative 1.

	KMZ-CA		*KMZ-OR*	
	Alternative 2	*Change from Alternative 1*	*Alternative 2*	*Change from Alternative 1*
Total angler days:				
• Party/charter	2,378	712	545	163
• Private boat	33,650	10,081	20,407	6,114
• Sum	36,028	10,793	20,952	6,277
Non-resident angler days:				
• Party/charter	2,197	658	281	84
• Private boat	17,027	5,101	4,673	1,400
• Sum	19,224	5,759	4,954	1,484
Non-resident angler expenditures (2012$):				
• Party/charter	$448,057	$134,223	$ 57,212	$ 17,140
• Private boat	953,502	285,658	261,700	78,402
• Sum	$1,401,558	$419,891	$318,912	$ 95,542

Total angler days in KMZ-CA and KMZ-OR under Alternative 2 obtained from Table IV-2. Breakdown of angler days between party/charter and private boat mode estimated from modal proportions provided in Table V-1. Number of angler days in each mode attributable to non-resident anglers estimated from non-resident proportions provided in Table V-2. Non-resident angler expenditures based on estimates of non-resident expenditure per angler day of $203.93 for party/charter mode and $56.00 for private boat mode (2012$).

The annual increase in non-resident expenditures under Alternative 2 relative to Alternative 1 is $419.9 thousand for KMZ-CA and $95.5 thousand for KMZ-OR (Table V-5). The associated effects in employment, income and output are shown in Table V-6.

V-6. Annual regional economic impacts associated with increase in ocean recreational expenditures in KMZ-CA by non-resident anglers under Alternative 2 relative to Alternative 1

KMZ-CA						
	Employment		*Labor Income*		*Output*	
Impact Type	*Jobs*	*% change from Alternative 1*	*$Millions*	*% change from Alternative 1*	*$Millions*	*% change from Alternative 1*
Direct	4.0		0.12		0.30	
Indirect	0.7		0.03		0.08	
Induced	0.8		0.03		0.09	
Total	**5.5**	**42.3**	**0.18**	**42.8**	**0.48**	**42.8**
KMZ-OR						
	Employment		*Labor Income*		*Output*	
Impact Type	*Jobs*	*% change from Alternative 1*	*$Millions*	*% change from Alternative 1*	*$Millions*	*% change from Alternative 1*
Direct	1.0		0.02		0.07	
Indirect	0.1		0.00		0.01	
Induced	0.1		0.00		0.01	
Total	**1.2**	**41.4**	**0.02**	**42.7**	**0.09**	**42.7**

Source: Reclamation 2011b, presented in 2012 dollars.
Employment measured in number of jobs. Labor income is dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals in the analysis area. Output represents dollar value of industry production.

V.D. Alternative 3 – Partial Facilities Removal of Four Dams

Alternative 3 is intended to provide the same habitat conditions as Alternative 2 – i.e., fish passage unencumbered by dams and a free-flowing river, as well as benefits of the KBRA. Therefore the regional economic impacts of this alternative on the ocean recreational fishery in KMZ-CA and KMZ-OR are expected to be the same as Alternative 2.

VI. Summary and Conclusions

The particular salmon stocks influenced by the no action and action alternatives are the SONCC coho ESU (which is listed under the ESA) and Klamath River fall and spring Chinook. Economic effects of the no action and action alternatives on the ocean recreational fishery as they relate to these stocks are as follows:

<u>SONCC coho ESU:</u> Coho retention has been prohibited in California's ocean recreational fishery since 1994 and Oregon has managed its coho fishery as a mark-selective fishery since 1999 to meet consultation standards for SONCC coho and other coho ESUs listed under the ESA. Little improvement in the status of the SONCC coho ESU is expected under the no action alternative. Thus current fishery prohibitions on coho retention are likely to continue into the future under this alternative. The action alternatives are expected to yield similar improvements in the viability of Klamath coho populations and advance the recovery of the SONCC coho ESU, but are unlikely to lead to de-listing since the ESU also includes stocks outside the Klamath

Basin whose viability is not affected by this action. Thus current coho fishery constraints in California and Oregon are expected to continue into the future under the action alternatives.

Klamath River Chinook

- *Economic benefits:* Under the no action alternative, average annual ocean recreational harvest of Klamath Chinook is estimated to be similar to what it was during 2001-05 (4,255 fish). Reflecting the constraining influence of Klamath Chinook on the availability of Chinook (all stocks) in the KMZ-CA and KMZ-OR management areas, Klamath Chinook harvest of 4,255 provides the opportunity for the ocean recreational fishery to harvest 25,707 Chinook (all stocks) south of Cape Falcon, Oregon. Average annual fishing effort associated with such harvest is 43,955 angler days and net economic value is $6.7 million.

  Under the action alternatives, annual ocean recreational harvest is estimated to increase by an average of 43 percent over the 2012-61 projection period. Average annual harvest under these alternatives is projected to include 6,075 Klamath Chinook and 36,702 total Chinook (all stocks). Associated fishing effort is 62,756 angler days and net economic value is $9.6 million. The increase in annual net economic value under the action alternatives relative to Alternative 1 is $2.9 million. The discounted present value of this increase over the 2012-61 period is $52.8 million (based on a discount rate of 4.125 percent).

  The harvest control rule underlying the Klamath Chinook harvest projections limits the harvest rate to 10 percent or less in years when pre-harvest escapements fall below 30,500 adult natural spawners. Escapements this low would likely be accompanied by major regulatory restrictions and adverse economic conditions similar to what was experienced in 2006. Such low escapements would occur in 66 percent fewer years under the action alternatives, with the greatest decline (-79 percent) occurring in the post-dam removal years.

- *Economic impacts*: Regional economic impacts associated with the no action and action alternatives are largely concentrated in KMZ-CA and KMZ-OR, where Klamath Chinook is the constraining stock. Regional impacts associated with the $1.2 million increase in non-resident angler expenditures in KMZ-CA and KMZ-OR under the no action alternative include 13 jobs, $0.42 million in labor income and $1.12 million in output in KMZ-CA, and three jobs, $0.08 million in labor income and $0.21 million in output in KMZ-OR. The additional $515.4 thousand in non-resident angler expenditures in KMZ-CA and KMZ-OR projected under the action alternatives is estimated to provide an additional six jobs, $0.18 million in labor income, and $0.48 million in output in KMZ-CA, and an additional one job, $0.02 million in labor income, and $0.09 million in output in KMZ-OR.

Main areas of uncertainty in this analysis include natural variability in biological and environmental parameters and uncertainty regarding future harvest management policies and gasoline prices. Gasoline prices can have a notable influence on angler expenditures associated with travel to the recreational site, as well as the cost of other recreational goods and services whose prices are sensitive to changes in energy costs.

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Appendix A. Salmon Fishery Management

In 1976 the U.S. Congress implemented the Magnuson Fishery Conservation and Management Act (now the Magnuson-Stevens Fishery Conservation and Management Act or MSFCMA), which established eight regional fishery management councils whose mandate was to phase out foreign fishing and manage domestic fisheries in the U.S. Exclusive Economic Zone (EEZ).[17] The Pacific Fishery Management Council (PFMC) – whose members include representatives of California, Oregon, Washington and Idaho – is the entity responsible for management of EEZ fisheries off the coasts of Washington, Oregon and California. The PFMC implemented the Pacific Coast Salmon Fishery Management Plan (FMP) in 1978. The FMP addresses management needs of multiple salmon stocks that originate in rivers along the Pacific coast. Each coastal state manages its recreational salmon fisheries (ocean and inriver) in coordination with the PFMC. State regulations for the ocean recreational fishery typically include measures such as area closures, season closures, gear restrictions, possession limits, minimum size limits, stock retention prohibitions, and mark-selective fishing.

Salmon stocks that originate in rivers south of Cape Falcon, Oregon generally limit their ocean migration to the area south of Falcon. The major salmon species harvested in the south-of-Falcon fishery are Chinook (*Oncorhynchus tshawytscha*) and coho (*O. kisutch*). The area south of Falcon is divided into six management areas: Monterey, San Francisco, Fort Bragg, Klamath Management Zone (KMZ), Central Oregon, and Northern Oregon. For purposes of this analysis, the KMZ (which straddles the Oregon-California border) is divided at the border into two areas: KMZ-OR and KMZ-CA.

Management of the ocean recreational fishery is complicated by the fact that multiple salmon stocks with different conservation objectives mix in the ocean harvest. These 'mixed stock' fisheries are managed on the general principle of 'weak stock' management, whereby harvest opportunity for more abundant stocks is constrained by the need to meet conservation objectives for weaker stocks.

PFMC management reflects conservation objectives for targeted stocks, consultation standards for weak stocks, and harvest allocation requirements (PFMC 2011):

- *Targeted stocks:* For ocean fisheries south of Cape Falcon, the major targeted stocks are Sacramento River fall Chinook (SRFC) and Klamath River fall Chinook (KRFC). Conservation objectives for these stocks[18] are as follows:

[17] The EEZ includes waters that extend 3-200 miles from the U.S. coast.
[18] The conservation objectives for KRFC and SRFC discussed here are intended to facilitate interpretation of historical fishery trends. In June 2011 the PFMC recommended modifications to these objectives to address new requirements of the MSFCMA; these changes will likely become effective in 2012.

o In 1989, following a period of sizeable KRFC harvests, low KRFC escapements and a major El Niño in 1982-83, the PFMC adopted more conservative harvest policies for KRFC, including a return of 34-35 percent of adult natural spawners and an escapement floor of 35,000 adult natural spawners (Klamath River Technical Team 1986, PFMC 1988). Figure A-1 depicts KRFC escapements during 1978-2010 relative to the escapement floor that was in effect during 1989-2006. In 2007 the floor was increased to 40,700 to help rebuild KRFC after the stock collapsed in 2006.

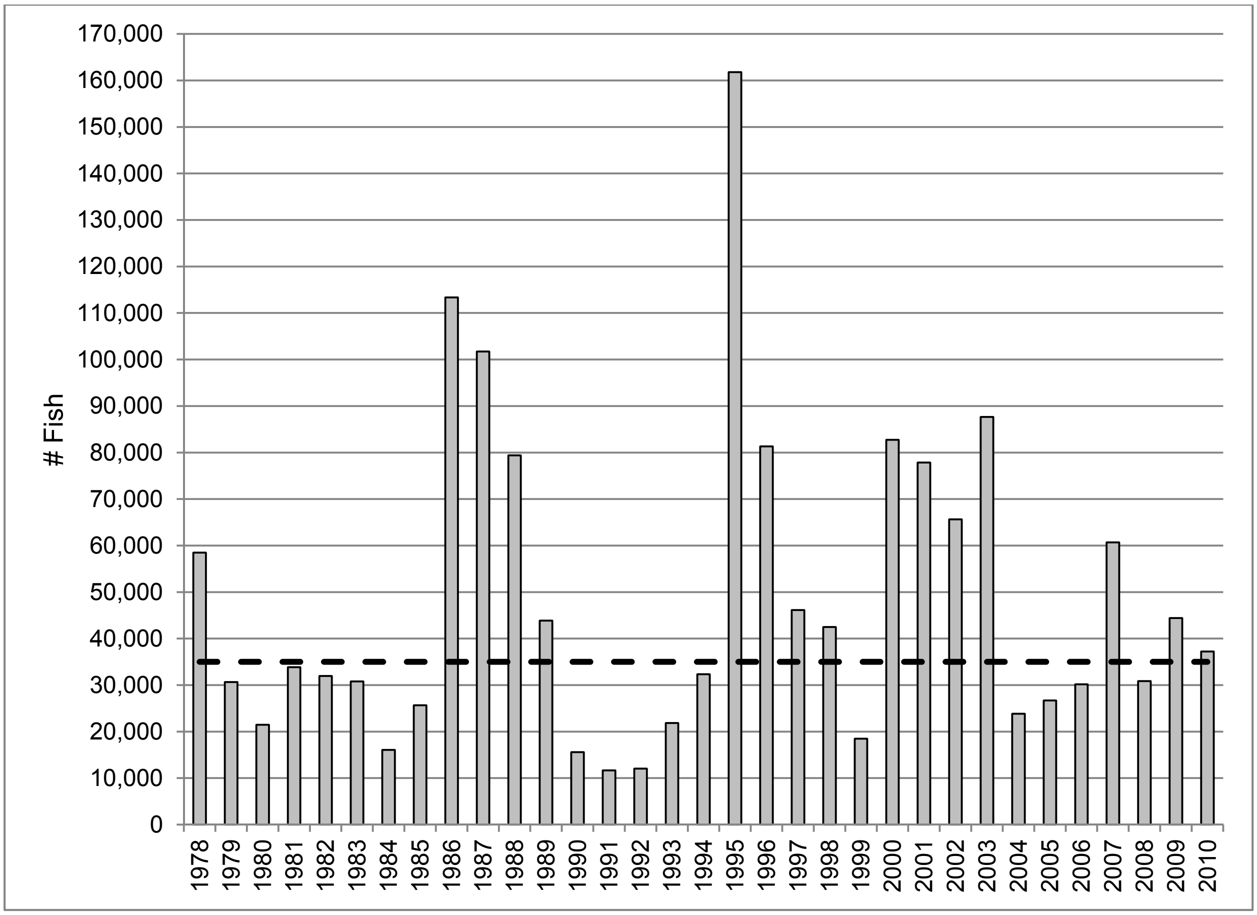

Figure A-1. Klamath River adult natural spawner escapement, 1978-2010. Dotted line represents 35,000 escapement floor in effect during 1989-2006 (source: PFMC 2011a)

o The conservation objective for SRFC is a spawner escapement goal of 122,000-180,000 hatchery and natural area adults. Figure A-2 depicts SRFC escapements during 1978-2010 relative to the escapement goal, which has been in effect since 1978.

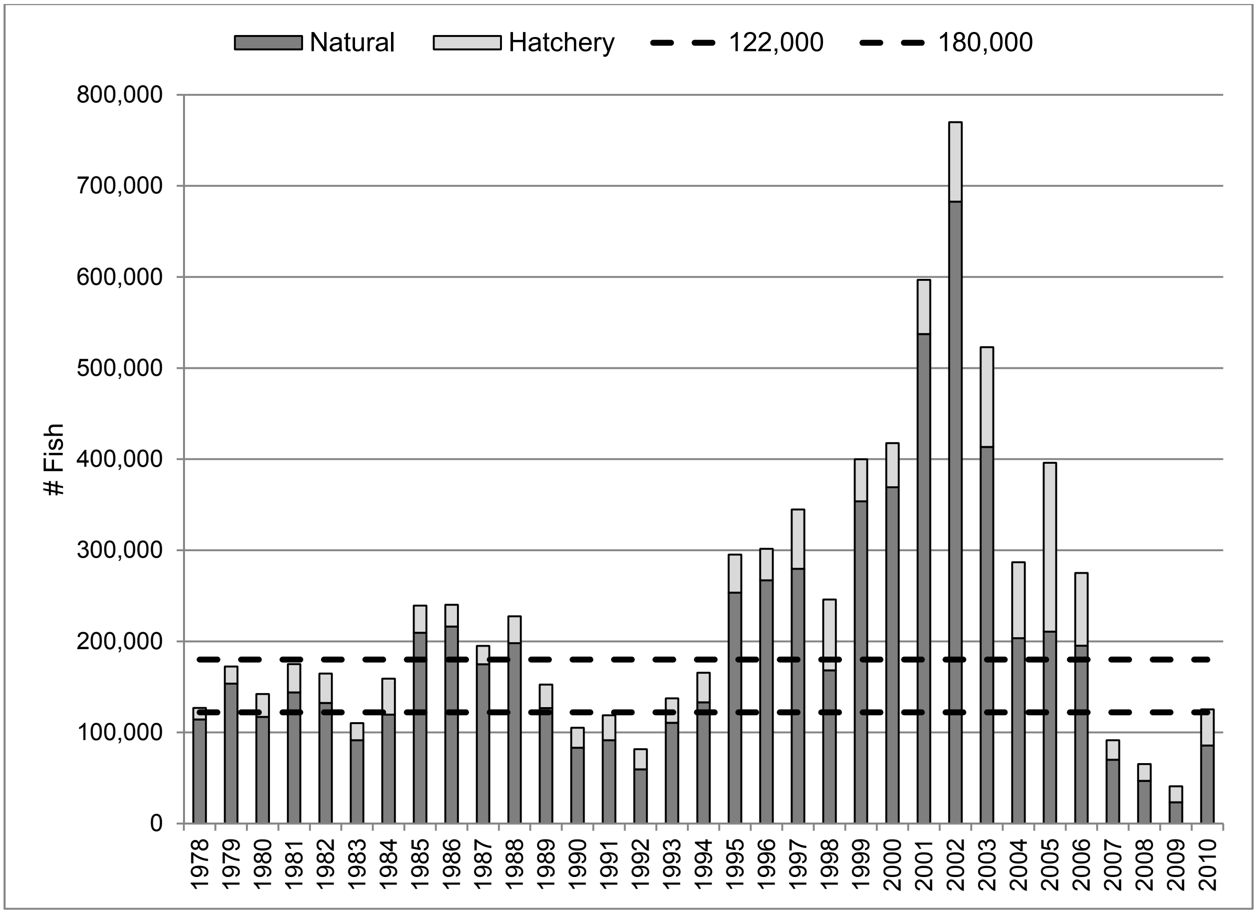

Figure A-2. Sacramento River adult spawner escapement (natural + hatchery), 1978-2010. Dotted lines represent PFMC escapement goal of 122,000-180,000 (source: PFMC 2011a).

- *Stocks listed under the Endangered Species Act (ESA):* The PFMC is bound by consultation standards for six ESA-listed Chinook and coho stocks that occur in the ocean fishery south of Cape Falcon.[19]

    - Sacramento River winter Chinook was listed as 'threatened' in 1989 and reclassified as 'endangered' in 1994. The current consultation standard includes area, season and size limit restrictions for ocean commercial and recreational fisheries from Point Arena, California to the U.S./Mexico border.
    - Central California Coast coho was listed as 'threatened' in 1996 and reclassified as 'endangered' in 2005. The consultation standard is a ban on coho retention in all commercial and recreational fisheries in California.
    - SONCC coho was listed as 'threatened' in 1997. The consultation standard caps the marine exploitation rate on Rogue/Klamath River hatchery coho at 13 percent.

[19] A seventh stock – Central Valley spring Chinook – was listed as 'threatened' in 1999. NMFS determined that PFMC-managed fisheries presented 'no jeopardy' to this stock.

- Oregon Coastal Natural (OCN) coho was listed as ‘threatened’ in 1998, de-listed in 2006 following a NMFS update of all its listing determinations, and re-listed in 2008 after the de-listing was successfully challenged in Court. OCN coho is managed on the basis of exploitation rates that vary with habitat production potential (freshwater and marine) – measured by parent spawner status and smolt-to-adult marine survival (PFMC 1999, OCN Work Group 2000).
- California Coastal Chinook (CCC) was listed as ‘threatened’ in 1999. Using KRFC as an indicator stock, the consultation standard for CCC caps the forecast harvest rate for age-4 KRFC in the ocean fishery at 16 percent.
- Lower Columbia Natural coho was listed as ‘threatened‘ in 2005. The consultation standard is a maximum exploitation rate of 15 percent (marine and Columbia River combined).

- *Stock rebuilding:* The PFMC designates a ‘conservation alert’ when a stock fails to meet its conservation objective in a single year and a ‘conservation concern’ when this happens in three consecutive years. A conservation alert may warrant precautionary management in the year of the alert, while a conservation concern (which is more indicative of a downward trend) may require a longer-term management strategy – including a stock rebuilding plan (PFMC 2003).

- *Allocation:* In 1993, the Department of Interior’s Office of the Solicitor issued an opinion requiring that 50 percent of Klamath-Trinity River salmon be reserved for the Yurok and Hoopa Valley Tribes (USDOI 1993). This was considerably higher than the 30 percent tribal reserve that was in effect during 1987-91 (Pierce 1998) and required reduced allocations to non-tribal fisheries. The 50-50 tribal/non-tribal allocation remains in effect today.

Table A-1 identifies years since 1994 when coho retention has been prohibited or the entire recreational fishery has been closed. The former correspond to years when coho abundance has been particularly low, the latter to years when both coho and Chinook abundances have been low.

Table A-1. Years of no coho retention (NoCoho), mark selective coho fishery (MSCoho), closure of Chinook and coho fisheries (Closure), and closure of Newport-area ports (ClosureNewport)[1] in the ocean recreational salmon fishery south of Cape Falcon, 1994-2010 – by management area.

Year	*Management Area*						
	Northern OR	*Central OR*	*OR KMZ*	*CA KMZ*	*Fort Bragg*	*SanFran*	*Monterey*
1994	NoCoho, Closure Newport	Closure	NoCoho	NoCoho	NoCoho	NoCoho	NoCoho
1995-97	NoCoho	NoCoho	NoCoho	NoCoho	NoCoho	NoCoho	NoCoho
1998-05	MSCoho	MSCoho	MSCoho	NoCoho	NoCoho	NoCoho	NoCoho
2006	MSCoho	MSCoho	MSCoho	NoCoho	NoCoho	NoCoho	NoCoho
2007	MSCoho	MSCoho	MSCoho	NoCoho	NoCoho	NoCoho	NoCoho
2008	MSCoho	MSCoho	MSCoho	Closure	NoCoho	Closure	Closure
2009	MSCoho	MSCoho	MSCoho	NoCoho	Closure	Closure	Closure
2010	MSCoho	MSCoho	MSCoho	NoCoho	NoCoho	NoCoho	NoCoho

Sources: PFMC 1998, 2011b.

[1] The Northern Oregon management area includes Tillamook and Newport-area ports.

Highlights of Table A-1 are as follows:

- Coho retention has been prohibited in California's ocean recreational fishery since 1994 to meet the consultation standard for Central California Coast coho (listed in 1996); this prohibition also meets the consultation standard for SONCC coho (listed in 1997). Coho retention was also prohibited in Oregon's ocean recreational fishery south of Cape Falcon in 1994 and strictly curtailed during 1995-97. In 1998, ODFW reopened the coho fishery as a mark-selective fishery – with a marked coho quota and season limits to ensure that the recreational fishery does not exceed maximum allowable exploitation rates for ESA-listed stocks – including Oregon Coastal Natural, Rogue/Klamath, and Lower Columbia Natural coho (PFMC 2011).

- During the prolonged drought in the 2000s, KRFC failed to achieve its conservation objective for three consecutive years (2004-06). The PFMC increased the adult natural spawner escapement floor from 35,000 to 40,700 as a rebuilding strategy; this strategy remains in effect today. During 2007-09, SRFC failed to achieve its conservation objective, triggering another conservation concern (Lindley *et al.* 2009). The KRFC concern resulted in major ocean recreational fishery restrictions in 2006. The SRFC concern lead to even more restrictive regulations, including ocean recreational fishery closures in 2008-09 in most of California.

It is important to note that KRFC natural spawner escapement – as depicted in Figure A-1 – is not necessarily indicative of stock abundance. Ocean abundance pertains to the number of fish that migrate to the ocean and (i) are harvested in ocean or inriver fisheries, (ii) contribute to natural or hatchery escapement, (iii) remain unharvested in the ocean, or (iv) are subject to natural mortality or non-retention (hooking or dropoff) mortality.[20] Figure A-3 provides an index of KRFC abundance that includes the escapement and harvest components of abundance (unharvested migrants and natural and non-retention mortality being more difficult to estimate).[21] The size of the escapement and harvest components of Figure A-3 depends on factors such as the extent of hatchery production, how much of the ocean abundance is made available for harvest, and how the available harvest is distributed among fishery sectors (ocean and inriver).

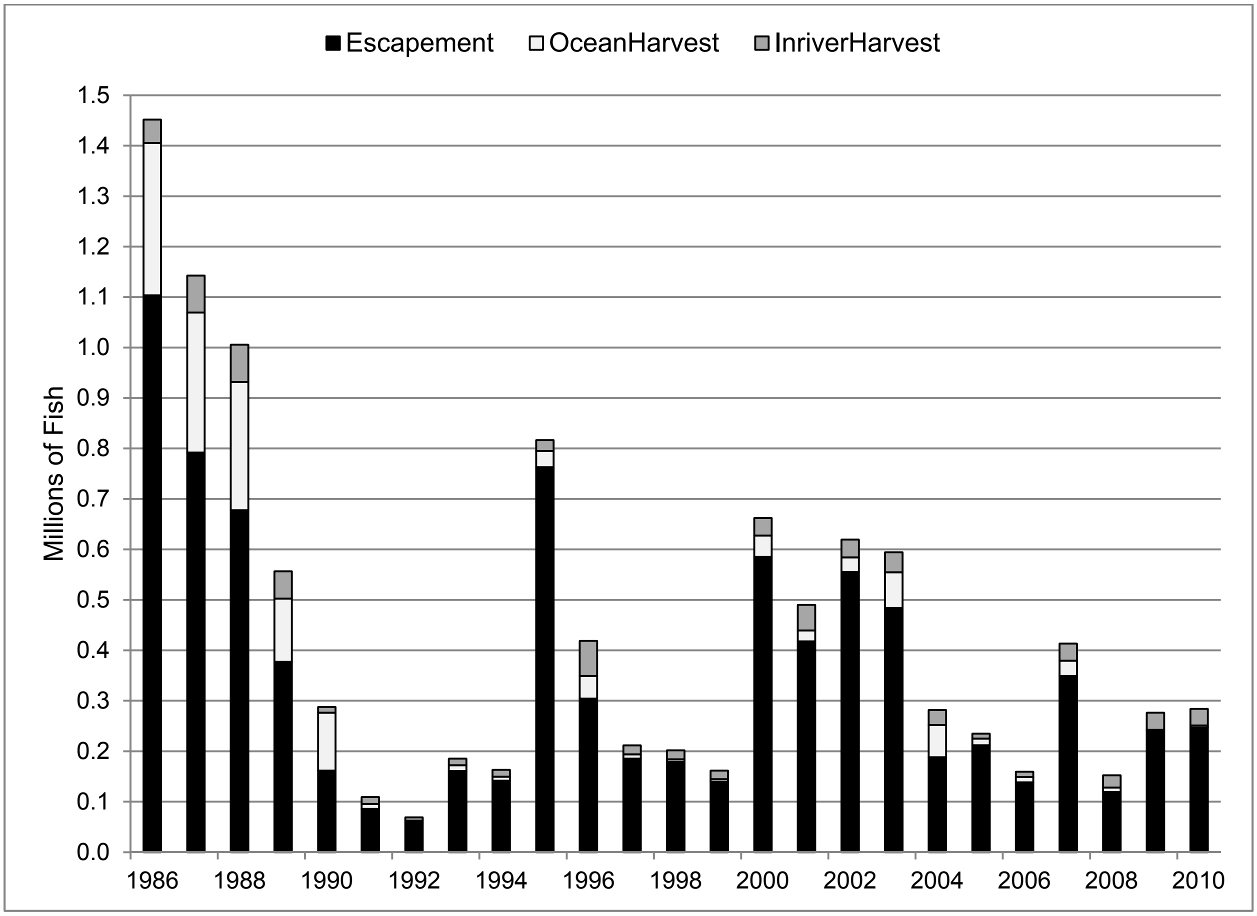

Figure A-3. Klamath River fall Chinook ocean abundance index (millions of fish), 1986-2010 (source: PFMC 2011a).

As with KRFC, SRFC adult spawner escapement – as depicted in Figure A-2 – is not indicative of stock abundance. Figure A-4 provides an index of ocean abundance for SRFC that includes the escapement and harvest components of abundance.[22] The addition of the harvest component reveals a pattern of abundance that differs considerably from the escapement pattern.

[20] Natural mortality is the mortality associated with factors such as disease and non-human predation. Hooking mortality pertains to fish that die after being hooked and released. Dropoff mortality pertains to fish that die after being dropped from the fishing gear as a result of such encounters with the gear.

[21] The escapements depicted in Figures A-1 and A-3 are not comparable. Figure A-1 includes natural escapement only, while Figure A-3 includes both natural and hatchery escapement.

[22] The escapement portion of Figure A-4 is comparable to escapement as depicted in Figure A-2, as both figures include both natural and hatchery escapement.

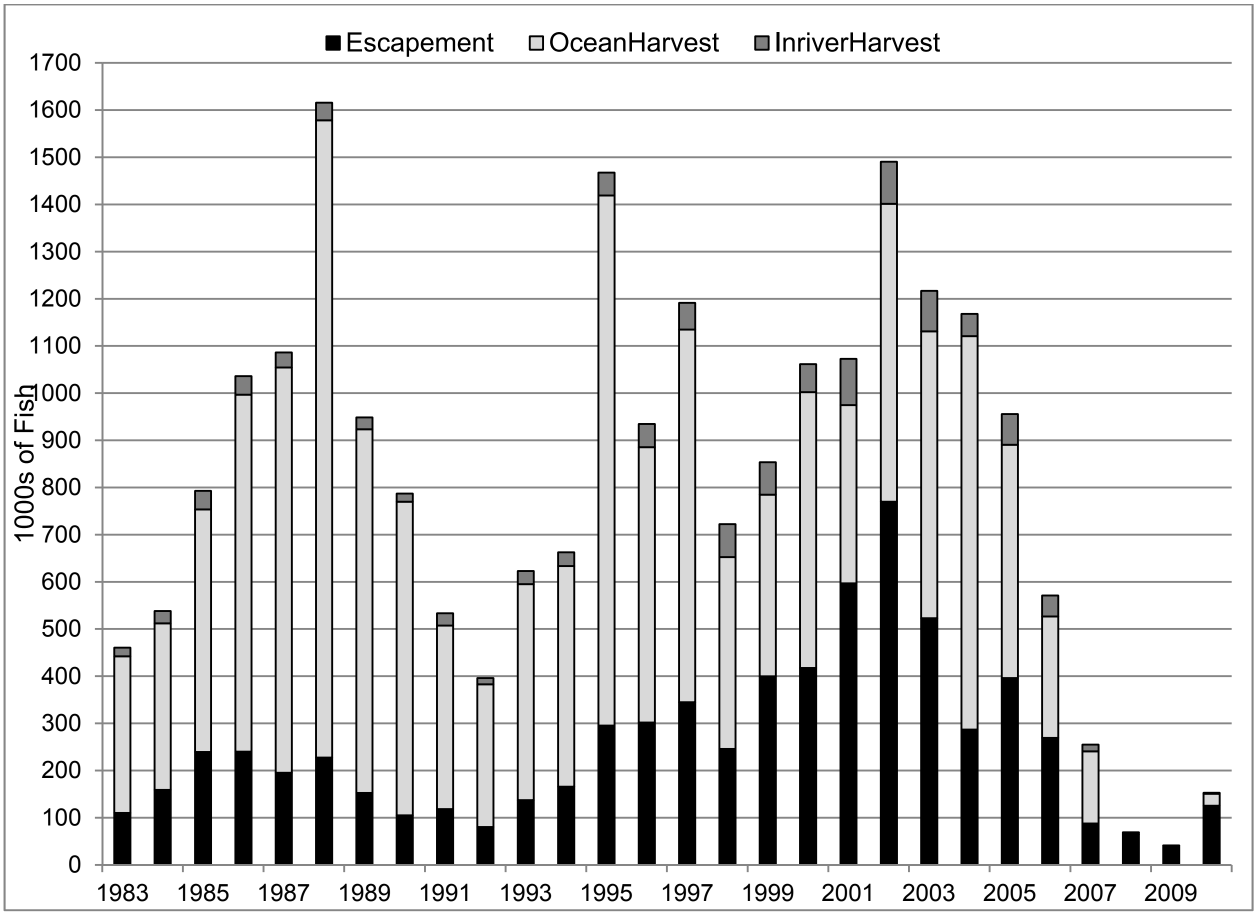

Figure A-4. Sacramento River fall Chinook ocean abundance index (1000s of fish), 1983-2010 (source: PFMC 2011a).

Escapement as a share of total SRFC abundance increased from an annual average of 21 percent during 1981-95 to 40 percent during 1996-2007 to 91 percent during 2008-10 – reflecting the effect of more conservative harvest policies over time (Figure A-4). The 91 percent estimate reflects the effects of stringent fishery regulations associated with record low stock conditions during 2008-10. It is not clear whether the record low SRFC abundances experienced in recent years signal a future pattern of persistently low abundances, are part of a cyclical pattern, or are events that may recur on a rare or occasional basis.

Appendix B. Methodologies Used to Quantify Economic Effects of No Action and Action Alternatives

This appendix provides documentation of how EDRRA model projections were used in combination with fishery data to quantify the economic effects of the no action and action alternatives on the ocean recreational fishery.

B.1. Estimation of Harvest, Effort and Net Economic Value

Table B-1 describes the equations used to estimate Klamath Chinook harvest, total Chinook harvest (all stocks), fishing effort (angler days) and net economic value under the no action and action alternatives. Numeric values of the parameters that appear in Table B-1 (α_i, $EXPAND_i$, $CONVERT_i$, NEVDAY) are provided in Table B-2. Derivation of the variable PCTHARV (row #1 of Table B-1) is documented in Appendix B.1.b.

B.1.a. Equations and Parameter Values

Table B-1. Equations used to project average ocean recreational harvest of Klamath Chinook and total Chinook and associated fishing effort and net economic value, by management area i and year t (2012-61), under the no action alternative (NAA) and dam removal alternative (DRA).

#	*No-action alternative (NAA/Alternative 1)*	*Dam removal alternative (DRA/Alts 2 and 3)*
1	$KLAMCHNK^{NAA} = KLAMCHNK_{mean(01\text{-}05)}$	$KLAMCHNK^{DRA} = KLAMCHNK^{NAA} \times PCTHARV$
2	$KLAMCHNK_i^{NAA} = \alpha_i \times KLAMCHNK^{NAA}$	$KLAMCHNK_i^{DRA} = \alpha_i \times KLAMCHNK^{DRA}$
3	$TOTCHNK_i^{NAA} = KLAMCHNK_i^{NAA} / EXPAND_i$	$TOTCHNK_{i,}^{DRA} = KLAMCHNK_{i,}^{DRA} / EXPAND_i$
4	$ANGLERDAYS_i^{NAA} = TOTCHNK_i^{NAA} \times CONVERT_i$	$ANGLERDAYS_i^{DRA} = TOTCHNK_i^{DRA} \times CONVERT_i$
5	$NEV_i^{NAA} = ANGLERDAYS_i^{NAA} \times NEVDAY$	$NEV_i^{DRA} = ANGLERDAYS_i^{DRA} \times NEVDAY$

Note: Variables with subscripts NAA and DRA pertain to outputs of the economic analysis. Variables with asterisked versions of these superscripts (NAA* and DRA*) pertain to outputs of the EDRRA model.

$KLAMCHNK^{NAA}$ = average annual ocean recreational harvest of Klamath River Chinook under NAA (# fish, all areas).
$KLAMCHNK_{mean(01\text{-}05)}$ = average ocean recreational harvest of Klamath River Chinook during 2001-05 (# fish, all areas).
$KLAMCHNK^{DRA}$ = average annual ocean recreational harvest of Klamath River Chinook under DRA (# fish, all areas).
PCTHARV = percent increase in Klamath Chinook harvest under DRA, as projected by EDRRA model (see Appendix B.1.b).

$KLAMCHNK_i^{NAA}$ = annual harvest of Klamath River Chinook (# fish) in area i under NAA.
$KLAMCHNK_i^{DRA}$ = annual harvest of Klamath River Chinook (# fish) in area i under DRA.
α_i = proportion of ocean recreational harvest of Klamath River Chinook occurring in area i under NAA and DRA (see Table B-2)

$TOTCHNK_i^{NAA}$ = annual Chinook harvest (# fish, all stocks) in area i under NAA $TOTCHNK_i^{DRA}$ = annual Chinook harvest (# fish, all stocks) in area i under DRA $EXPAND_i$ = expansion factor used to project Chinook harvest (all stocks) associated with access to Klamath Chinook in each area i under NAA AND DRA (see Table B-2) $ANGLERDAYS_i^{NAA}$ = annual number of angler days in area i under NAA $ANGLERDAYS_i^{DRA}$ = annual number of angler days in area i under DRA $CONVERT_i$ = conversion factor used to convert Chinook harvest (all stocks) to angler days (see Table B-2) NEV_i^{NAA} = annual net economic value (2012$) in area i under NAA NEV_i^{DRA} = annual net economic value (2012$) in area i under DRA NEVDAY = net economic value (consumer surplus) per angler day (see Table B-2)

Table B-2. Parameter values used to estimate Klamath Chinook and total Chinook harvest (all stocks), angler days and net economic value by management area under the no-action and action alternatives.

Parameter	Management Area						
	Monterey	SanFran	FtBragg	KMZ-CA	KMZ-OR	CentralOR	NorthOR
α_i	0.032	0.121	0.314	0.203	0.195	0.097	0.040
$EXPAND_i$	1.000	1.000	1.000	0.049	0.149	1.000	1.000
$CONVERT_i$	1.649	1.194	1.215	1.435	2.641	2.400	3.529
NEVDAY	$152.37	$152.37	$152.37	$152.37	$152.37	$152.37	$152.37

α_i = proportion of Klamath River Chinook harvested by ocean recreational fishery in management area I, estimated using 2001-05 ocean recreational fishery data (data source: Michael O'Farrell, NMFS).

$EXPAND_i$ = ratio of total Chinook harvest (all stocks) to Klamath Chinook harvest in management area i, estimated using 2001-05 ocean recreational fishery data (data source: Michael O'Farrell, NMFS).

$CONVERT_i$ = ratio of total angler days to total Chinook harvest in area i, estimated using 2001-05 ocean recreational fishery data (data source: PFMC 2011).

NEVDAY = $152.37 (2012 dollars). See Appendix C for details regarding derivation.

B.1.b. Derivation of PCTHARV

The percent increase in Klamath Chinook harvest under the DRA relative to the NAA projected by the EDRRA model (PCTHARV) was estimated by Hendrix (2011) as follows:

$$PCTHARV = 1/T \sum_{t=1,\ldots,T} \{Median_{t,j=1,\ldots,1000} [(KLAMCHNK_{t,j}^{DRA*} - KLAMCHNK_{t,j}^{NAA*}) / KLAMCHNK_{t,j}^{NAA*}]\} \quad [B1]$$

where

$KLAMCHNK_{t,j}^{NAA*}$ = ocean recreational harvest of Klamath Chinook projected for year t and iteration j under the NAA by the EDRRA model;

$KLAMCHNK_{t,j}^{DRA*}$ = ocean recreational harvest of Klamath Chinook projected for year t and iteration j under the DRA by the EDRRA model;

the term in [ ] is the percent difference between DRA harvest and NAA harvest projected by the EDRRA model for each iteration j=1,…,1000 and year t=1,..,T;

$Median_{t,j=1,\ldots,1000}$ [ ] is the median of the 1000 values of [ ] generated for year t;

$1/T \sum_{t=1,\ldots,T}$ {$Median_{t,j=1,\ldots,1000}$ [ ]} is the mean of the median values of [ ], calculated over the years t=1.,…,T.

B.2. Estimation of Discounted Present Value of Net Economic Value

The NED analysis (Section IV) involved estimation of the discounted present value of annual net economic value (NEV) for the ocean recreational fishery; this requires that a discount factor be applied to NEV in each year of the 50-year projection period. In order to estimate NEV for each year t, average annual NEV (all areas) projected for Alternative 1 (Table IV-1) was multiplied by a factor that reflects the interannual variation in Klamath Chinook harvest relative to mean harvest – as projected by the EDRRA model under the NAA. This factor is applicable to NEV as well as harvest, due to the proportional relationship between harvest and NEV. Specifically:

$$NEV_t^{Alt1} = NEV^{Alt1} \text{ x } KLAMCHNK_t^{NAA*} / KLAMCHNK_{mean(12\text{-}61)}^{NAA*} \qquad [B2]$$

where

NEV^{Alt1} = average annual net economic value (all areas) under Alternative 1 ($6.7 million, according to Table IV-2), and

$KLAMCHNK_t^{NAA*} / KLAMCHNK_{mean(12\text{-}61)}^{NAA*}$ = the ratio of Klamath Chinook harvest in each year t to annual Klamath Chinook harvest averaged over the projection period t=2012,…,2061, as projected by the EDRRA model for the NAA.

Annual net economic value for each year t under Alternative 2 (NEV_t^{Alt2}) was similarly calculated, as follows:

$$NEV_t^{Alt2} = NEV^{Alt2} \text{ x } KLAMCHNK_t^{DRA*} / KLAMCHNK_{mean(12\text{-}61)}^{DRA*} \qquad [B3]$$

where

NEV^{Alt2} = average annual net economic value (all areas) under Alternative 2 ($9.6 million, according to Table IV-3), and

$KLAMCHNK_t^{DRA*}$ / $KLAMCHNK_{mean(12\text{-}61)}^{DRA*}$ = the ratio of Klamath Chinook harvest in each year t to annual Klamath Chinook harvest averaged over the projection period t=2012,…,2061, as projected by the EDRRA model for the DRA.

The discounted present value (DPV) of future increases in net economic value under Alternative 2 relative to Alternative 1 was estimated as follows:

$$DPV= \sum_{t=2012,\ldots,2061} [(NEV_t^{Alt2} - NEV_t^{Alt1})] (1+r)^{-t} \qquad [B4]$$

where

NEV_t^{Alt1} and NEV_t^{Alt2} = net economic value projection in year t for Alternatives 1 and 2 respectively, calculated on the basis of equations [B2] and [B3] above; and

r = discount rate.

B.3. Estimation of Percent of Years when DRA Harvest > NAA Harvest

The percent of years in which DRA harvest exceeds NAA harvest (PCTYRS) was estimated from EDRRA model outputs as follows:

$$PCTYRS=1/T \sum_{t=1,\ldots,T} \{(1/1000)\ COUNT_{t,j=1,\ldots,1000} [KLAMCHNK_{t\,j}^{DRA*}>KLAMCHNK_{t,j}^{NAA*}]\} \qquad [B5]$$

where

$KLAMCHNK_{t,j}^{NAA*}$ = ocean recreational harvest of Klamath Chinook projected by EDRRA model for year t and iteration j under the NAA;

$KLAMCHNK_{t,j}^{DRA*}$ = ocean recreational harvest of Klamath Chinook projected by EDRRA model for year t and iteration j under the DRA;

$\{(1/1000)\ COUNT_{t,,j=1,\ldots,1000} [\ ]\}$ = percent of iterations j=1,…,1000 when DRA harvest > NAA harvest, estimated separately for each year t. [ ] is shorthand for what appears in brackets in equation [B5]);

$1/T \sum_{t=1,\ldots,T} \{(1/1000)\ COUNT_{t,,j=1,\ldots,1000} [\ ]\}$ = mean of $\{(1/1000)\ COUNT_{t,,j=1,\ldots,1000} [\ ]\}$ over years t=1,…,T.

B.4. Estimation of Percent Difference in Frequency of Pre-Harvest Escapement ≤ 30,500

The percent difference between the NAA and DRA in the frequency of pre-harvest adult natural spawner escapements ≤ 30,500 (PCTDIFF) was estimated from EDRRA model outputs as follows:

$$PCTDIFF = 1/T \sum_{t=1,\ldots,T} \{[COUNT_{t,j=1,\ldots,1000}^{DRA*} (ESCAPE_{t\,j}^{DRA*} \leq 30{,}500) - COUNT_{t,j=1,\ldots,1000}^{NAA*} (ESCAPE_{t\,j}^{NAA*} \leq 30{,}500)] / COUNT_{t,j=1,\ldots,1000}^{NAA*} (ESCAPE_{t\,j}^{NAA*} < 30{,}500)\} \quad [B6]$$

where

$ESCAPE_{t\,j}^{NAA*}$ = pre-harvest escapement of Klamath Chinook projected by the EDRRA model for year t=1,…,T and iteration j=1,…,1000 under the NAA;

$ESCAPE_{t\,j}^{DRA*}$ = pre-harvest escapement of Klamath Chinook projected by the EDRRA model for year t=1,…,T and iteration j=1,…,1000 under the DRA;

$COUNT_{t,j=1,\ldots,1000}^{NAA*} (ESCAPE_{t,j}^{NAA*} \leq 30{,}500)$ = number of iterations j in year t when $ESCAPE_{t\,j}^{NAA*} \leq 30{,}500$ under the NAA;

$COUNT_{t,j=1,\ldots,1000}^{DRA*} (ESCAPE_{t,j}^{DRA*} \leq 30{,}500)$ = number of iterations j in year t when $ESCAPE_{t\,j}^{DRA*} \leq 30{,}500$ under the DRA;

$[COUNT_{t,j=1,\ldots,1000}^{DRA*} (\ ) - COUNT_{t,j=1,\ldots,1000}^{NAA*} (\ )]/COUNT_{t,j=1,\ldots,1000}^{NAA*} (\ )$ = percent difference between DRA and NAA in number of iterations when pre-harvest adult natural spawner escapement ≤ 30,500, estimated separately for each year t. ( ) is shorthand for what appears in parentheses in equation [B6];

$1/T \sum_{t=1,\ldots,T} \{[COUNT_{t,j=1,\ldots,1000}^{DRA*} (\ ) - COUNT_{t,j=1,\ldots,1000}^{NAA*} (\ )]/COUNT_{t,j=1,\ldots,1000}^{NAA*} (\ )\}$ = mean of percent differences over years t=1.,…,T.

C. Estimation of Net Economic Value Per Angler Day
C.1. Data and Model Specification

The primary data used to estimate net economic value (NEV) per day of ocean recreational salmon fishing come from an economic survey of ocean recreational salmon anglers sponsored by the National Marine Fisheries Service. The data were collected from ocean recreational anglers intercepted at California, Oregon and Washington fishing ports in 2000. Data elements collected included the following: number of ocean recreational trips taken by each respondent over the past twelve months, size of the party (number of anglers and non-anglers) accompanying the respondent, respondent's zip code of residence, respondent's household income (defined in categorical ranges), number of work hours per week, boat ownership, and detailed travel cost and expenditure information for the intercepted trip. The present study utilized a subset of the survey data, namely data collected from anglers intercepted at ports south of Cape Falcon, Oregon who identified salmon as their primary target species.

The demand equation that served as the basis for the NEV estimate is as follows:

$$DAYS_i = \alpha + \beta_1\, TC_i + \beta_2\, INCOME_i + \beta_3\, BOATOWN_i \quad [C1]$$

where

$DAYS_i$ = the number of ocean salmon trips taken by respondent i in the twelve months prior to the interview,
TC_i = the cost of making the intercepted fishing trip,
$INCOME_i$ = the respondent's household income, and
$BOATOWN_i$ = a binary variable indicating whether or not the respondent owned a boat.

Net economic value (consumer surplus) per angler day was estimated on the basis of the travel cost coefficient β_1 estimated in equation [C1] as follows:

$$NEV = -1/\beta_1 \quad [C2]$$

The following are assumptions underlying equation [C1]:

- We assume that all salmon trips reported for the past twelve months entail costs that were similar to the costs associated with the intercepted trip. This assumption is less than ideal but unavoidable given the nature of the available economic data[23].

- We follow Sohngen (2000) in defining the travel cost variable. Specifically, the opportunity cost of time is valued at one-third of annual household income divided by 2040 (number of hours worked per year by full time workers). Driving cost is calculated as $0.12 multiplied by the round trip distance in miles.[24]

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[23] Although less than ideal, these assumptions are not unprecedented and, in fact, are rather common in travel cost modeling. See Shrestha, Seidl and Moraes (2002) and Huppert (1989) for examples.
[24] This figure is based on AAA's estimate of variable cost per mile driving costs for 2000 (the year of our survey).

- Whether on-site expenditures should be included with travel cost is a topic of some debate, although contemporary studies seem to favor the use of on-site costs in the calculation of travel cost. Beal (1995), Herath and Kennedy (2004), Rolfe and Prayage (2007) and Prayaga et al. (2010) are four examples. We include costs incurred on-site (charter fees, fuel for private boats, etc.) as part of total travel cost.

- It is conventional with single site travel cost models to discard trips that cannot reasonably be assumed to be day trips; Parsons (2003) suggests travel times in excess of 3 to 4 hours as an upper limit. For reasons cited by Smith and Kopp (1980) as follows, we removed overnight trips from the dataset:

  > "The travel cost method assumes the trip is intended for the use of the recreational site only and not to serve multiple objectives. As we expand the set of origin zones to include progressively more distant units the assumption that each trip is a single purpose excursion becomes more untenable" (Smith and Kopp 1980, p 65).

- Household income was collected in a categorical format (1=$0.0K-$15.5K, 2=$15.5K-$31.2K, 3=$31.2K-$46.8K, 4=$46.8K-$62.4K, 5=$62.4K-$78.0K, 6=$78.0K-$93.3K, 7=$93.3K-$109.2K, 8=$109.2K-$124.8K, 9=$124.8K-$140.0K,10= >$140.0K). Income was entered in the model as the midpoint of the reported income range, with a value of $140K used to represent income category (10).

C.2. Estimation Method and Results

Because the data were collected via on-site interviews, we observe only positive values for the number of trips taken by each respondent. To account for this feature, we estimated equation [C1] using a zero-truncated negative binomial model.[25] Results are shown in Table C-1. Net economic value (consumer surplus), estimated in the manner of equation [C2], is $270.27 per angler day.

Table C-1. Results of zero truncated, negative binomial regression analysis

Log likelihood = -3271.1437 Number of obs = 828			LR chi2(3) = 77.45 Prob > chi2 = 0.0000 Adjusted r^2 = 0,0117		
Explanatory Variable	*Coefficient*	*Standard Error*	*z*	*P >/z/*	*Variable Mean*
Tripcost	-0.00370	0.00077	-4.78	0.000	37.23
Income ($1000s)	0.00174	0.00147	1.18	0.237	59.33
Ownboat	0.88543	0.10917	8.11	0.000	0.63
Constant	2.41889	0.13635	17.74	0.000	
Dependent variable = number of ocean salmon fishing days in the past 12 months (mean=23.5)					

[25] For more in-depth discussions of count data models in recreation demand see Shaw (1988), Hellerstein (1991) and Hellerstein and Mendelsohn (1993).

C.3. References

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