APPENDIX E
COMPARING SALMON INCOME IMPACT ESTIMATES FROM IO-PAC AND FEAM MODELS

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Comparing Salmon Income Impact Estimates from IO-PAC and FEAM Models

The Council is in the process of transitioning its fisheries economic impact estimation methods from models developed based on key informant interview data and the Fisheries Economic Assessment Model (FEAM) to a structure based on survey-based data collections and the NWFSC's IO-PAC model. The Council first started using IO-PAC-based multipliers for commercial and recreational fisheries in its analysis of the 2013-2014 groundfish harvest specifications.[1]

The main issue delaying the adoption of IO-PAC-based multipliers to analyze commercial Pacific salmon fisheries was the different treatment of seafood processing cost structures assumed between the FEAM and IO-PAC-based models. The FEAM model for commercial salmon fisheries was developed assuming that processing costs were more a function of the weight of salmon processed than the ex-vessel value of raw fish delivered to the processor. The IO-PAC model for commercial fisheries assumes total processing costs are a fixed proportion of the exvessel value of raw fish purchased by the processor. This difference was perceived to be relatively more significant for salmon fisheries than for most groundfish fisheries due to the wide variations in exvessel prices between different salmon species (e.g., Chinook generally command a higher price than coho, chum and pinks), and among stocks or runs within the same species (e.g., in Columbia River fisheries, spring Chinook command a higher price than Chinook salmon caught later in the year)[2].

Results of a statistical analysis of processor cost data collected by the West Coast Economic Data Collection (EDC) program were presented to the Science and Statistical Committee's Economics Subcommittee in September 2014. Linear regressions were performed using several years of available EDC data to test alternative hypotheses that processors' revenues were proportional to either (1) the weight (weight-based approach) or (2) the cost (dollar markup or cost-based approach) of salmon purchased by processors. Results of the analysis showed that the weight-based approach appeared to fit the 2012 data better than the cost-based approach and also supported differential treatment for Chinook versus other salmon species. However similar regressions run using 2011 data yielded implausible results for the weight-based approach. Although regression results under the cost-based hypothesis didn't always fit the data as well as the weight-based approach, the results were at least plausible (i.e., non-negative) for all years examined. Although there appears to be merit to both approaches, based on the lack of consistency in regression results for the weight-based approach, the SSC recommended that IO-PAC multipliers be used along with the cost-based approach to estimate processors' contributions and calculate income impacts of commercial salmon fisheries going forward.

IO-PAC-based multipliers for estimating recreational fisheries economic impacts have been in use for groundfish fisheries since the 2013-14 groundfish harvest specifications, but had not yet been applied to recreational salmon fisheries. Both IO-PAC and FEAM-based methods apply fixed estimates of recreational anglers' fishing trip-related expenditures to the official counts of recreational angler trips by region and

[1] For a detailed description of IO-PAC see Appendix 2, pages A24-A69 in:
http://www.pcouncil.org/wp-content/uploads/GF15_16_SpexFEISJanuary2015.pdf

A technical description of a FEAM-type commercial fishery model can be found beginning on page 107 in: http://www.afsc.noaa.gov/Publications/ProcRpt/PR%202005-01.pdf

[2] Although trollers may expend a similar amount of time, labor and other inputs pursuing different types of salmon, they can earn much higher revenues catching the higher-valued fish. Similarly while a troll-caught Chinook may cost processors three times as much as a similar size coho, the time and resources required to process the two fish are likely to be similar.

"mode" (charter vessel, private vessel, or jetty). Compared with the FEAM-based estimates, the IO-PAC recreational income impact multipliers were constructed using more current regional economic data and a more recent survey of angler expenditures. The SSC therefore recommended that IO_PAC multipliers be used for calculating income impacts of recreational salmon fisheries going forward.

The Council adopted the SSC recommendations at its November 2014 meeting. Consequently, IO-PAC-based multipliers will be used for estimating both commercial and recreational salmon fishery income impacts displayed in the *Review of 2014 Ocean Salmon Fisheries* and in all subsequent salmon review and other pre-season process documents. However since the economic data underlying the IO-PAC models has only been available relatively recently, comparisons of results between the FEAM and IO-PAC models are limited to years from 2010 onward. In the following tables, income impact estimates are displayed in terms of thousands of inflation-adjusted 2014 dollars by year and region during the 2010-2014 period.

Table E-1 compares estimated commercial troll salmon fisheries income impacts calculated using IO-PAC and FEAM-based models each year during 2010-2014. The table also shows for each port area the "Processed Share", or the proportion of salmon revenue landed that is assumed to be processed in the port area. In the FEAM-based model this was assumed to be 100% in all cases. IO-PAC income impact estimates generally tend to be smaller than FEAM estimates for most port areas with the exception of Ilwaco, Coos Bay and San Francisco. IO-PAC state-level multipliers for the State of Oregon model are also somewhat larger than FEAM. The largest discrepancy between the two models' estimates in percentage terms occurs for ports like Tillamook, Brookings and Crescent City where IO-PAC incorporates a very low local processing share. This factor accounts for at least some of the difference in estimated impacts for ports where the IO-PAC processed share parameter is less than 100%[3].

Table E-2 compares estimated recreational salmon fisheries income impacts calculated using IO-PAC and FEAM-based models each year during 2010-2014. IO-PAC recreational multipliers are greater than FEAM-based estimates for all port areas (local-level and state-level models) except Tillamook. In many cases the discrepancies between the two models' estimates are greater than 50 percent. Most of the difference is presumably attributable to the much more recent angler expenditure data used to calibrate the IO-PAC multipliers.

The differences in data, assumptions and methodologies mean that estimates generated by the two models are not directly comparable. That is, it may be meaningless to compare more recent income impacts in a particular region to those prior to 2010, when at least a portion of the apparent change may actually be the result of switching to a new model. Consequently any comparisons of income impacts over time in Chapter IV are confined to pointing out trends appearing over 2010-2014, during which period the IO-PAC-based models and multipliers are applied. Those wishing to illustrate the magnitude of recent fisheries relative to earlier (pre-2010) historical periods may find annual exvessel value data for the commercial fishery and the total number of angler-trips in the recreational fishery useful for that purpose.

[3] Another factor is that the multipliers used in the FEAM commercial salmon impact model were calibrated from a 1998 IMPLAN model and year 2000 PacFIN landings and key informant-based estimates of costs; whereas the IO-PAC model is based on much more current landings and survey-based economic data.

TABLE E-1. Comparison of Income Impact Estimates from IO-PAC and FEAM Models of Pacific Ocean Troll and Columbia River Net Commercial Salmon Fisheries by State and Port Area [Thousands of inflation-adjusted 2014 dollars]..

Model:	State-Level Model Impacts			Local-Level Model Impacts															
Fishery:	Pacific Ocean Troll Fishery																	Col. River Net Fishery	
	Washington	Oregon	California	Neah Bay	La Push	Westport	Ilwaco	Astoria	Tilla-mook	Newport	Coos Bay	Brookings	Crescent City	Eureka	Fort Bragg	San Francisco	Monterey	Washington	Oregon
2010																			
IOPAC	5,270.6	5,066.2	1,730.5	240.1	385.2	3,676.1	90.9	929.9	152.4	1,241.4	1,087.9	183.8	0.0	32.9	1,444.9	154.5	98.2	7,864.3	6,818.3
FEAM	5,252.7	4,258.2	2,236.8	341.7	537.2	4,061.4	88.2	961.8	279.4	1,396.2	947.6	373.8	0.0	35.9	1,811.4	142.9	163.7	11,132.5	9,901.4
% diff (IOPAC-FEAM)	+0.3%	+19.0%	-22.6%	-29.7%	-28.3%	-9.5%	+3.0%	-3.3%	-45.4%	-11.1%	+14.8%	-50.8%		-8.4%	-20.2%	+8.1%	-40.0%	-29.4%	-31.1%
2011																			
IOPAC	2,896.6	4,360.6	7,719.6	551.1	218.7	1,344.4	91.7	234.3	56.1	507.9	2,263.7	252.4	34.5	422.4	4,062.5	2,573.4	626.9	9,485.2	5,984.9
FEAM	2,919.5	3,557.4	9,095.6	780.0	307.8	1,456.8	86.9	239.0	101.1	555.4	1,903.2	512.7	69.1	444.7	5,035.2	2,262.6	995.1	12,616.5	8,518.0
% diff (IOPAC-FEAM)	-0.8%	+22.6%	-15.1%	-29.4%	-28.9%	-7.7%	+5.4%	-2.0%	-44.5%	-8.5%	+18.9%	-50.8%	-50.1%	-5.0%	-19.3%	+13.7%	-37.0%	-24.8%	-29.7%
2012																			
IOPAC	4,025.8	7,729.1	20,665.1	825.4	479.1	1,405.4	224.0	691.0	273.4	1,909.7	2,213.8	343.3	19.8	680.9	3,925.0	12,366.7	3,672.6	5,823.2	3,659.7
FEAM	3,991.0	6,240.2	22,759.3	1,162.6	671.0	1,485.1	206.4	693.0	487.0	2,081.8	1,825.1	709.0	39.6	697.6	4,782.4	10,825.9	5,852.9	7,560.7	5,144.7
% diff (IOPAC-FEAM)	+0.9%	+23.9%	-9.2%	-29.0%	-28.6%	-5.4%	+8.5%	-0.3%	-43.9%	-8.3%	+21.3%	-51.6%	-49.9%	-2.4%	-17.9%	+14.2%	-37.3%	-23.0%	-28.9%
2013																			
IOPAC	4,775.7	13,545.1	38,374.5	520.6	481.8	2,692.7	75.7	291.0	336.4	1,772.6	7,324.1	619.9	115.0	1,926.3	10,982.9	22,737.6	2,612.7	10,617.6	6,520.3
FEAM	4,680.2	10,907.9	39,738.2	716.1	665.9	2,842.7	68.6	291.1	595.2	1,912.0	6,068.5	1,271.5	226.7	1,953.4	13,112.7	19,483.5	4,073.8	13,934.9	9,167.4
% diff (IOPAC-FEAM)	+2.0%	+24.2%	-3.4%	-27.3%	-27.6%	-5.3%	+10.3%	-0.0%	-43.5%	-7.3%	+20.7%	-51.2%	-49.3%	-1.4%	-16.2%	+16.7%	-35.9%	-23.8%	-28.9%
2014																			
IOPAC	4,548.2	26,010.3	19,732.3	416.1	489.7	1,576.1	1,133.9	1,555.0	682.9	6,239.2	8,994.2	1,201.8	110.5	840.9	7,048.9	11,056.8	675.3	14,457.3	7,039.1
FEAM	4,467.7	21,035.7	20,690.4	578.4	678.7	1,655.0	1,034.8	1,527.6	1,175.4	6,834.8	7,509.5	2,448.6	220.6	870.5	8,505.4	9,551.3	1,055.1	20,070.3	10,554.3
% diff (IOPAC-FEAM)	+1.8%	+23.6%	-4.6%	-28.1%	-27.8%	-4.8%	+9.6%	+1.8%	-41.9%	-8.7%	+19.8%	-50.9%	-49.9%	-3.4%	-17.1%	+15.8%	-36.0%	-28.0%	-33.3%
Processed Share	Assumed Percent Locally Processed																		
IOPAC	55%	64%	44%	25%	90%	90%	90%	44%	19%	52%	100%	0%	0%	100%	100%	100%	38%	90%	44%
FEAM	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

TABLE E-2. Comparison of Income Impact Estimates from IO-PAC and FEAM Models of Pacific Ocean and Columbia River (Buoy 10) Recreational Salmon Fisheries by State and Port Area [Thousands of inflation-adjusted 2014 dollars]]

Model:	State-Level Model Impacts			Local-Level Model Impacts															
Fishery:	Pacific Ocean Recreational Fishery																	Buoy 10 Fishery	
	Washington	Oregon	California	Neah Bay	La Push	Westport	Ilwaco	Astoria	Tillamook	Newport	Coos Bay	Brookings	Crescent City	Eureka	Fort Bragg	San Francisco	Monterey	Washington	Oregon
2010																			
IOPAC	17,223.6	5,270.5	9,450.9	690.6	323.9	6,488.0	3,292.8	816.4	503.1	989.0	454.3	233.8	13.0	291.1	680.8	2,875.9	1,709.3	1,460.4	1,602.1
FEAM	8,449.7	3,212.7	3,770.5	453.5	226.2	4,431.4	2,119.9	620.9	553.4	867.9	344.1	233.5	8.7	195.6	428.5	1,742.4	1,160.6	779.2	1,281.7
% diff (IOPAC-FEAM)	+103.8%	+64.1%	+150.6%	+52.3%	+43.2%	+46.4%	+55.3%	+31.5%	-9.1%	+14.0%	+32.1%	+0.1%	+50.4%	+48.8%	+58.9%	+65.1%	+47.3%	+87.4%	+25.0%
2011																			
IOPAC	14,866.1	5,064.0	18,471.3	678.5	351.9	5,251.3	2,969.3	642.4	495.3	969.4	552.9	245.8	48.5	1,074.8	1,564.1	5,597.1	2,656.7	1,261.5	1,646.2
FEAM	7,231.3	3,111.5	7,485.1	447.9	245.2	3,544.8	1,943.0	484.6	542.0	840.2	418.8	245.5	32.2	724.5	989.8	3,427.4	1,810.2	688.2	1,317.3
% diff (IOPAC-FEAM)	+105.6%	+62.7%	+146.8%	+51.5%	+43.5%	+48.1%	+52.8%	+32.6%	-8.6%	+15.4%	+32.0%	+0.1%	+50.4%	+48.3%	+58.0%	+63.3%	+46.8%	+83.3%	+25.0%
2012																			
IOPAC	15,981.7	6,693.5	30,720.8	854.1	335.2	5,948.4	2,825.7	533.4	466.1	1,103.8	917.1	746.6	512.9	1,920.7	1,565.2	10,017.7	4,382.2	1,676.2	2,211.2
FEAM	7,840.5	4,084.3	12,599.1	568.1	234.5	4,026.9	1,868.7	394.8	511.9	961.3	695.2	745.0	342.0	1,301.2	987.3	6,178.7	2,999.7	911.9	1,762.4
% diff (IOPAC-FEAM)	+103.8%	+63.9%	+143.8%	+50.4%	+42.9%	+47.7%	+51.2%	+35.1%	-8.9%	+14.8%	+31.9%	+0.2%	+49.9%	+47.6%	+58.5%	+62.1%	+46.1%	+83.8%	+25.5%
2013																			
IOPAC	16,254.4	8,328.1	31,034.2	988.6	358.3	5,789.6	2,950.5	593.5	551.3	1,185.9	1,583.2	833.5	450.4	1,939.5	1,902.1	12,047.6	2,710.0	1,562.6	2,275.0
FEAM	7,947.2	5,063.7	12,802.3	659.2	250.1	3,926.9	1,946.6	443.6	602.2	1,030.5	1,199.1	829.1	299.7	1,317.5	1,205.6	7,427.1	1,830.4	832.6	1,813.7
% diff (IOPAC-FEAM)	+104.5%	+64.5%	+142.4%	+50.0%	+43.3%	+47.4%	+51.6%	+33.8%	-8.5%	+15.1%	+32.0%	+0.5%	+50.3%	+47.2%	+57.8%	+62.2%	+48.1%	+87.7%	+25.4%
2014																			
IOPAC	23,363.0	12,559.6	25,904.3	1,088.5	484.2	8,427.5	4,557.4	1,052.7	977.3	2,880.8	1,572.0	696.0	296.3	1,411.6	1,901.3	9,784.0	2,560.9	2,273.3	3,854.3
FEAM	11,344.6	7,711.5	10,776.8	729.2	344.0	5,687.7	2,936.7	794.9	1,068.6	2,503.1	1,190.5	693.2	198.0	960.2	1,203.4	6,051.8	1,740.8	1,213.6	3,082.8
% diff (IOPAC-FEAM)	+105.9%	+62.9%	+140.4%	+49.3%	+40.8%	+48.2%	+55.2%	+32.4%	-8.6%	+15.1%	+32.0%	+0.4%	+49.7%	+47.0%	+58.0%	+61.7%	+47.1%	+87.3%	+25.0%