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UNITED STATES DISTRICT COURT

EASTERN DISTRICT OF CALIFORNIA

THE DELTA SMELT CASES, SAN LUIS & DELTA-MENDOTA WATER AUTHORITY, *et al.* v. SALAZAR, *et al.* (Case No. 1:09-cv-407)	1:09-cv-407 OWW GSA 1:09-cv-422 OWW GSA 1:09-cv-631 OWW GSA 1:09-cv-892 OWW GSA PARTIALLY CONSOLIDATED WITH: 1:09-cv-480 OWW GSA
STATE WATER CONTRACTORS v. SALAZAR, *et al.* (Case No. 1:09-cv-422)	**SUPPLEMENTAL DECLARATION OF DR. RICHARD B. DERISO IN SUPPORT OF MOTION FOR INTERIM RELIEF/PRELIMINARY INJUNCTION**
COALITION FOR A SUSTAINABLE DELTA, *et al.* v. UNITED STATES FISH AND WILDLIFE SERVICE, *et al.* (Case No. 1:09-cv-480)	
METROPOLITAN WATER DISTRICT v. UNITED STATES FISH AND WILDLIFE SERVICE, *et al.* (Case No. 1:09-cv-631)	Date: January 20, 2010 Time: 9:00 a.m. Ctrm: 3 Judge: Hon. Oliver W. Wanger
STEWART & JASPER ORCHARDS, *et al.* v. UNITED STATES FISH AND WILDLIFE SERVICE, *et al.* (Case No. 1:09-cv-892)	

I, Dr. Richard B. Deriso, declare:

I. INTRODUCTION

1. In my previous declarations, the first dated July 31, 2009 and the second dated November 13, 2009, I used classical statistics to explain the quantitative effects analysis contained in the 2008 Delta Smelt Biological Opinion ("BiOp") prepared by the U.S. Fish and Wildlife Service ("FWS"). I used this approach to be consistent with the models and data analysis that FWS used, but I also explained the clear errors and major departures from well-accepted scientific standards that I identified. My review was limited to the data and information contained in the BiOp itself and the administrative record.

2. In preparing this declaration, I have focused specifically on the two "Reasonable and Prudent Alternative" Components of the BiOp (Components 1 and 2) that operate to limit water exports by restricting OMR flows in the winter and spring periods, beginning as early as December 1 and running potentially to June 30. This work included further analysis of the data contained in the BiOp, as well as data received through a Freedom of Information Act ("FOIA")

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request to FWS.[1] In this declaration, I have employed additional statistical approaches to evaluate any potential relationships between Old and Middle River ("OMR") flows and population growth for both adults and juveniles. After conducting several analyses of the available data using a variety of statistical approaches, I have reconfirmed the result that I reached in my previous declarations, namely, that the data does not show that OMR flows have a statistically significant effect on the population growth rates of either adults or juveniles; i.e., for either winter or spring flows. Moreover, in this declaration I establish that a relationship between winter OMR flows and the salvage rate exists only at very negative flows, and the complete absence of a relationship between spring OMR flows and salvage rate.

3. My qualifications and experience are set forth in my previous declaration, Docket #401, at ¶¶ 5-10 and Exhibits A and B thereto.

II. RPA COMPONENT 1 – ADULTS

A. Actions 1 and 2 Involve Setting OMR Flows During the Adult Life Stage of the Smelt

4. The BiOp's RPA Component 1 is divided into two parts labeled by FWS as "Actions 1 and 2," and involves limiting OMR flows with the intent to protect the species.

5. Action 1 is triggered first based on a determination by FWS using turbidity and other criteria. Action 1 limits exports so that the average daily OMR flow is no more negative than -2,000 cfs for a total duration of 14 days, with a 5-day running average no more negative than -2,500 cfs (within 25 percent). BiOp at 329 (Administrative Record ["AR"] at 000344).

6. After Action 1 ends, it is followed immediately by Action 2, which if triggered will last until spawning begins or a certain water temperature is reached. Action 2 limits the range of net daily OMR flows to no more negative than -1,250 cfs to -5,000 cfs. Specific OMR

[1] The FOIA request was submitted by the Metropolitan Water District of Southern California to FWS on August 10, 2009. FWS responded by returning a disc with approximately half of the data requested on October 29, 2009. FWS referred the remainder of the request to the U.S. Bureau of Reclamation ("BOR"). On November 23, 2009, after my last declaration was filed, BOR provided most of the balance of the data requested.

flows within this range are recommended by the Smelt Working Group depending on certain factors, such as sampling data, salvage data, flow, and turbidity. BiOp at 352 (AR at 000367).

7. Both Actions involve the setting of OMR flows within the range of -1,250 cfs to -5,000 cfs.

B. The Data Does Not Support the Conclusion That Winter OMR Flows Have a Statistically Significant Effect on the Population Growth Rate

8. In my previous declaration, I explained that standard practice in fisheries stock assessment requires evaluation of the effect of salvage on the population growth rate. The population growth rate represents the relative increase or decrease in adults from one year to the next, or generation to generation. I analyzed the data to determine if there is a relationship between the adult salvage rate and the population growth rate. I also analyzed the data to determine if there is a relationship between winter OMR flows and the population growth rate. In both analyses, I found that the data does not support the conclusion that either salvage rate or OMR flows has a statistically significant effect on the population growth rate. See Docket #401 at ¶¶ 66-74.

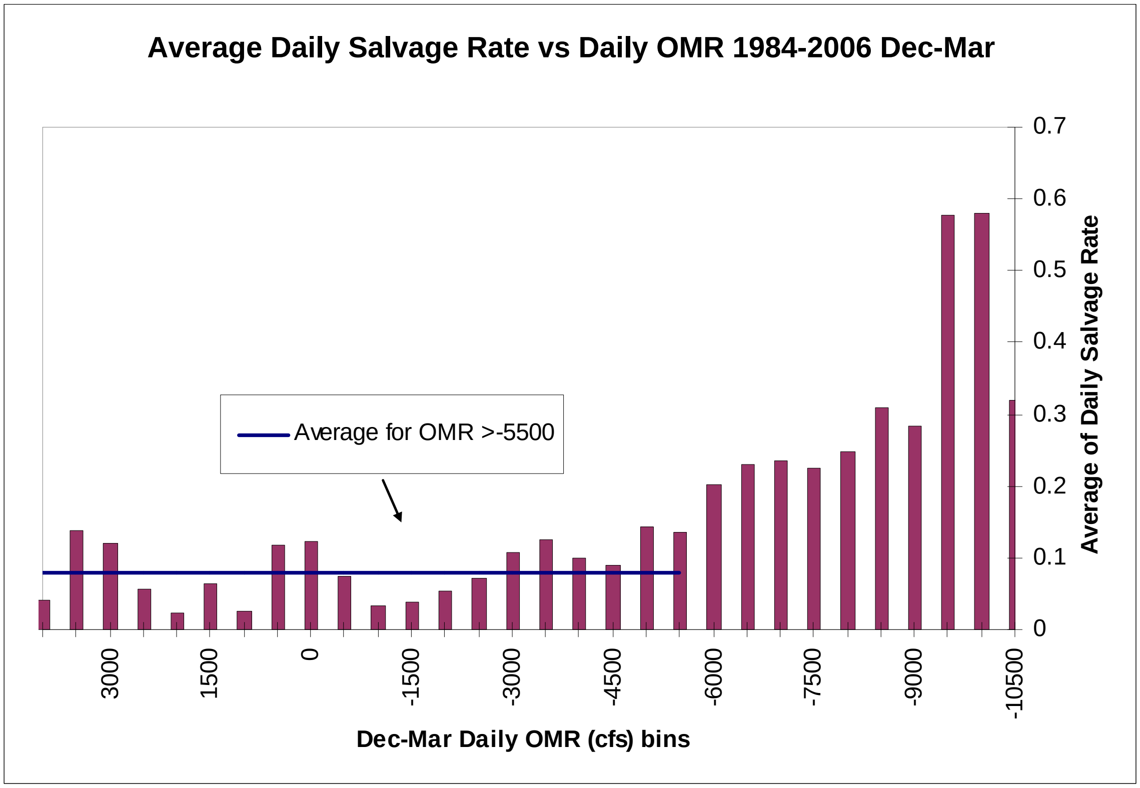
1. Daily Data Shows That the Salvage Rate Is Essentially Flat Until OMR Flows Reach -5500 Cfs

9. In analyzing Component 1, I evaluated the relationship between daily December-March OMR flows and the adult salvage rate (i.e., cumulative salvage index) so I could determine whether flows and salvage were correlated during this period. FWS provided daily OMR flows from 1984 to 2006, so I grouped those daily flows into “bins,” or sets of like data, in increments of 500 cfs.[2]

10. I then calculated the average daily salvage rate for each of the flow bins. The daily salvage rate is equal to the number of fish salvaged in a given day divided by the prior year Fall Midwater Trawl (“FMWT”) index, except that in December the current year FMWT index is used

[2] The bins are labeled by the most negative number in the bin, e.g., a bin labeled -1500 includes flows from -1000 cfs to -1500 cfs.

(as December falls after the FMWT has been completed but is in the same calendar year). Daily salvage rates for all days selected[3] with flow that falls within a given 500 cfs bin were averaged to produce the average daily salvage rates shown in the histogram below.



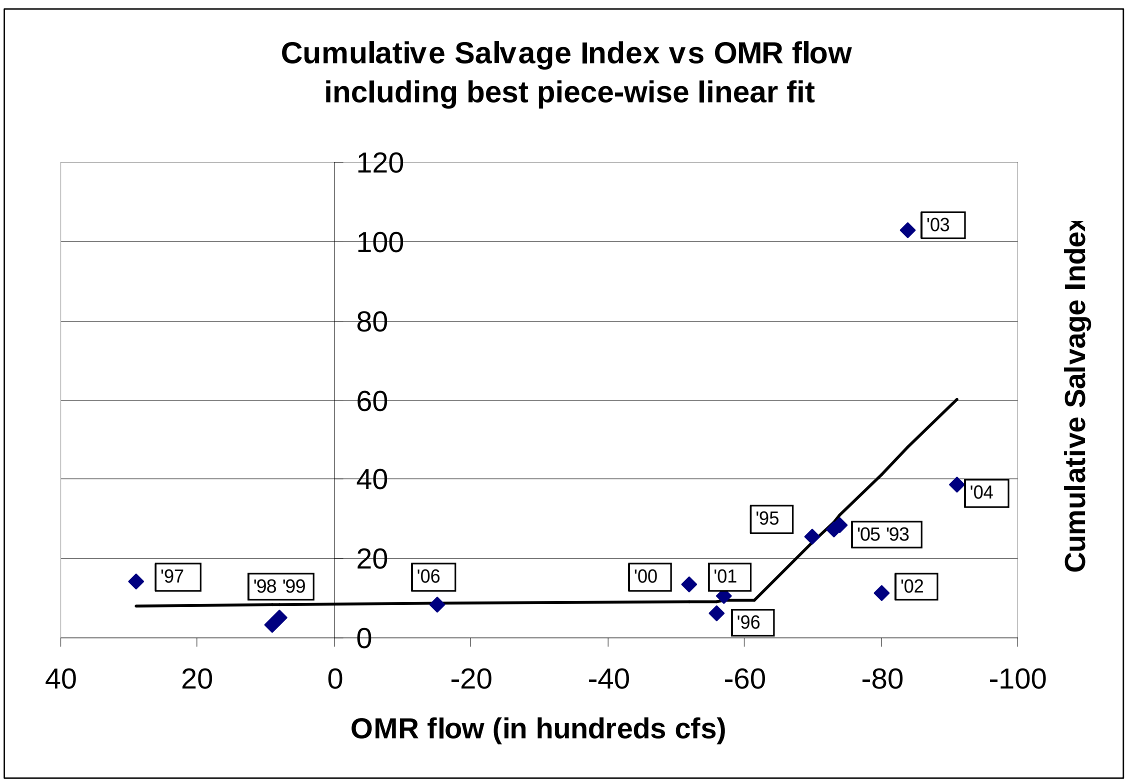
11. As can be seen visually in the graph above, it is only at flows more negative than approximately -5,500 cfs that the average daily salvage rate begins to increase with flows, with the highest average salvage rates occurring with the bins -9,500 cfs and -10,000 cfs.

12. When all of the daily salvage rates are added together for the 1984-2007 period, it is evident that approximately 80 percent of the December-March salvage rate occurs with daily OMR flows more negative than -5500 cfs. Moreover, at flows less negative, there is simply no correlation between flows and salvage rate. In fact, the salvage rate for the bin at 0 cfs is actually greater than the bin for -4500 cfs.

[3] The method of data selection follows an approximation to the trigger for RPA Action 1 in that data for a given year occurs after the first day in which a three-day average of turbidity exceeds 12 NTU. Turbidity, salvage, and OMR flows were provided through the FOIA request described in footnote 1 above. I excluded the years that were excluded from Figure B-13 in the BiOp, namely, 1987, 1989-1992, 1994, and 2007.

2. Using a Weight of the Evidence Approach, a Model Incorporating OMR Flows Does Not Have Substantial Support

13. In my prior declaration, I plotted a graph of the relationship between December-March OMR flows and the cumulative salvage index. This graph was used to explain the clear errors FWS committed when constructing its analysis in Figure B-13 of the BiOp. Because Figure B-13 uses salvage-weighted OMR flows which are not listed anywhere in the BiOp, I visually estimated a magnified version of the OMR flow curve in Figure B-13 and interpolated the data points for each year. *See* BiOp at 348 (AR at 000363). I was also limited to the years 1993-2006 because the BiOp only provides a table of the cumulative salvage index dating back to 1993. *See* BiOp at 386 (AR 000401). My prior analysis is depicted in the graph below, for reference.



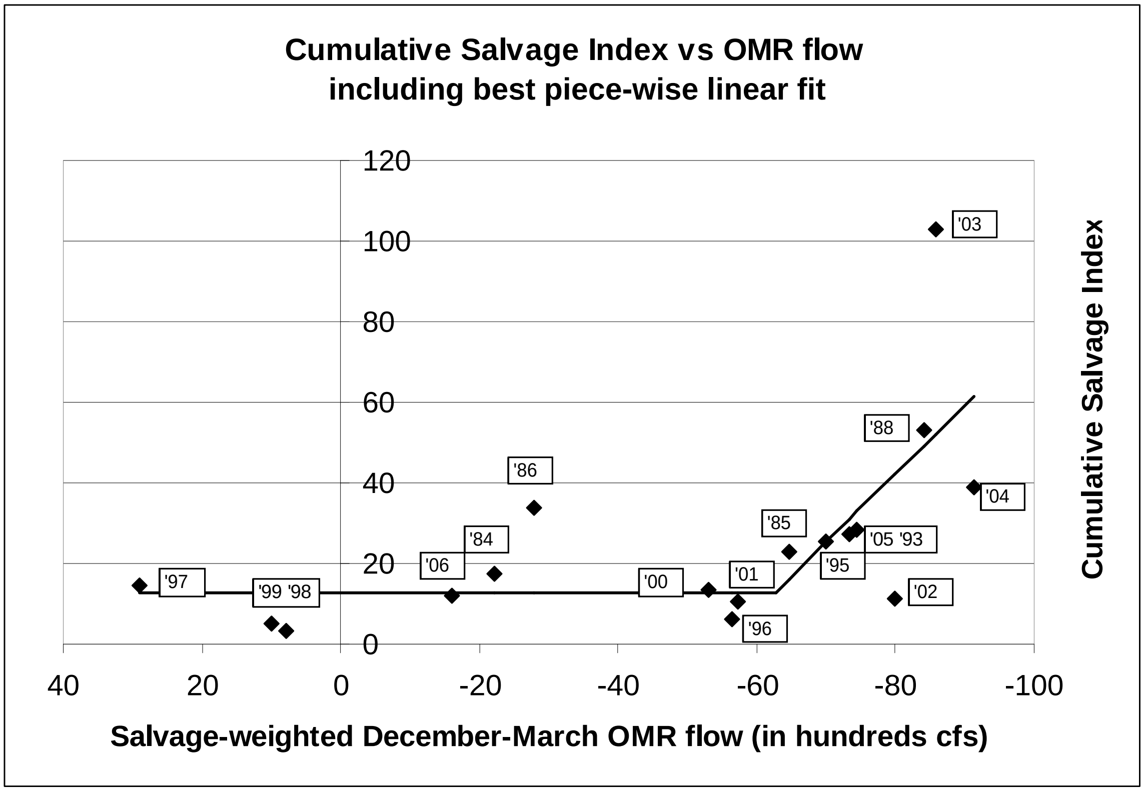
14. In response to the FOIA request, FWS provided daily salvage data and daily OMR flow data for the months December-March for years dating back to 1982. With this data, I was able to construct salvage-weighted OMR flows for the period 1984-2006 to correspond with the x-axis in Figure B-13 of the BiOp. To construct the data table below, I also calculated December-

March salvage for the same years and used FMWT data available at: http://www.delta.dfg.ca.gov/data/mwt/charts.asp. I excluded the same years of low turbidity that were excluded in Figure B-13 (1987, 1989-1992, 1994, and 2007).

Year	Salvage-Weighted OMR	Salvage Dec-March	FMWT year-1	Cumulative Salvage Index
1984	-2226	2309	132	17.49
1985	-6458	4151	182	22.81
1986	-2787	3716	110	33.78
1988	-8409	14848	280	53.03
1993	-7450	4425	156	28.37
1995	-7006	2608	102	25.57
1996	-5643	5634	899	6.27
1997	2909	1828	127	14.39
1998	784	1027	303	3.39
1999	992	2074	420	4.94
2000	-5299	11493	864	13.30
2001	-5727	8003	756	10.59
2002	-7985	6865	603	11.38
2003	-8577	14305	139	102.91
2004	-9133	8148	210	38.80
2005	-7338	2018	74	27.27
2006	-1600	324	27	12.00

15. The OMR data in the table is very similar to the data used in my previous declaration, but the analysis made in this declaration can now be extended back in time to 1984 to correspond with the time period analyzed in Figure B-13 in the BiOp.

16. I then fitted a piece-wise linear model to the cumulative salvage index as a function of December-March salvage-weighted OMR flows. To fit a piece-wise linear model, I plotted the data on a graph and tested the "fit" of straight lines to the data points using a well-accepted, objective statistical approach called maximum likelihood estimation. The BiOp used this approach in Figure B-14, but applied it to raw salvage numbers whereas I used the cumulative salvage index. *See* BiOp at 350 (AR at 000365). As I explained in my previous declaration, raw salvage numbers are not proportional to the total population and thus they do not reflect population level effects. *See* Docket #401 at ¶¶ 52-61. The results of my piece-wise linear model are similar to the results shown in my previous declaration with the slope of the initial piece not significantly different from zero (p-value > 0.1).



17. I also fitted a piece-wise linear model to the cumulative salvage index as a function of December-March average OMR flows, as opposed to salvage-weighted flows. The results are similar to the results shown in my previous declaration with the slope of the initial piece not significantly different from zero (p-value > 0.1). The break point occurs at approximately -7200 cfs.

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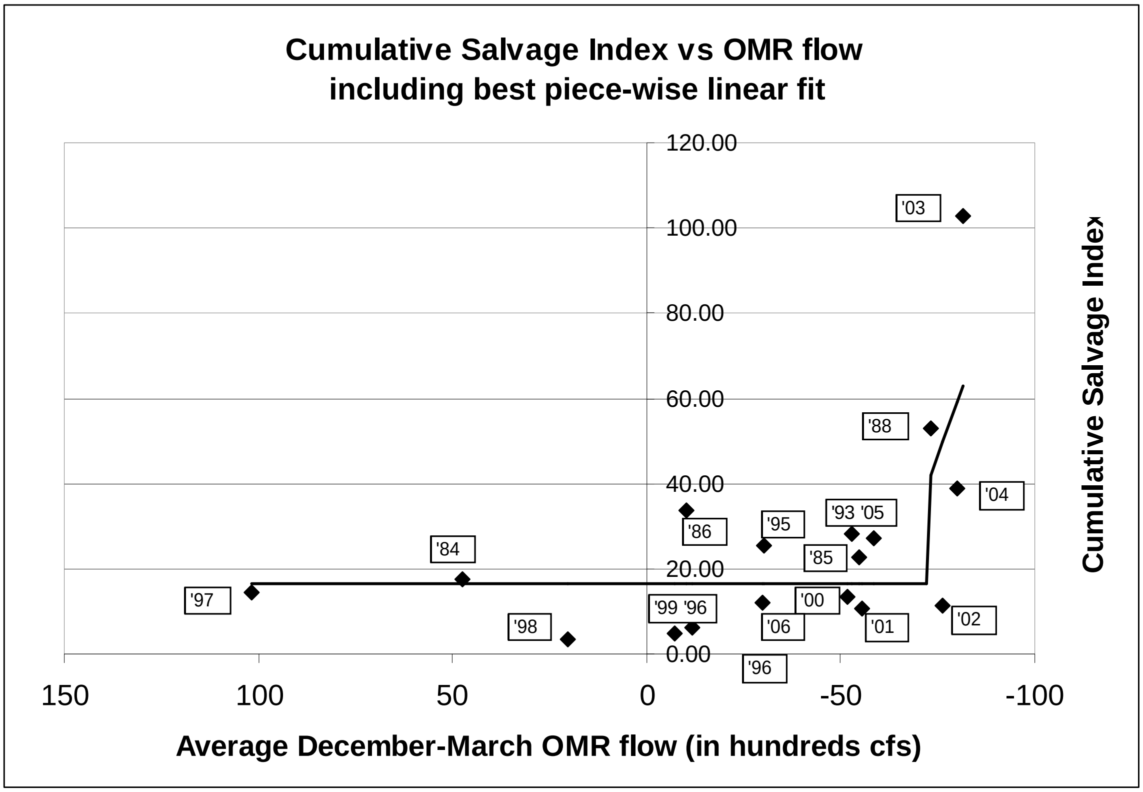
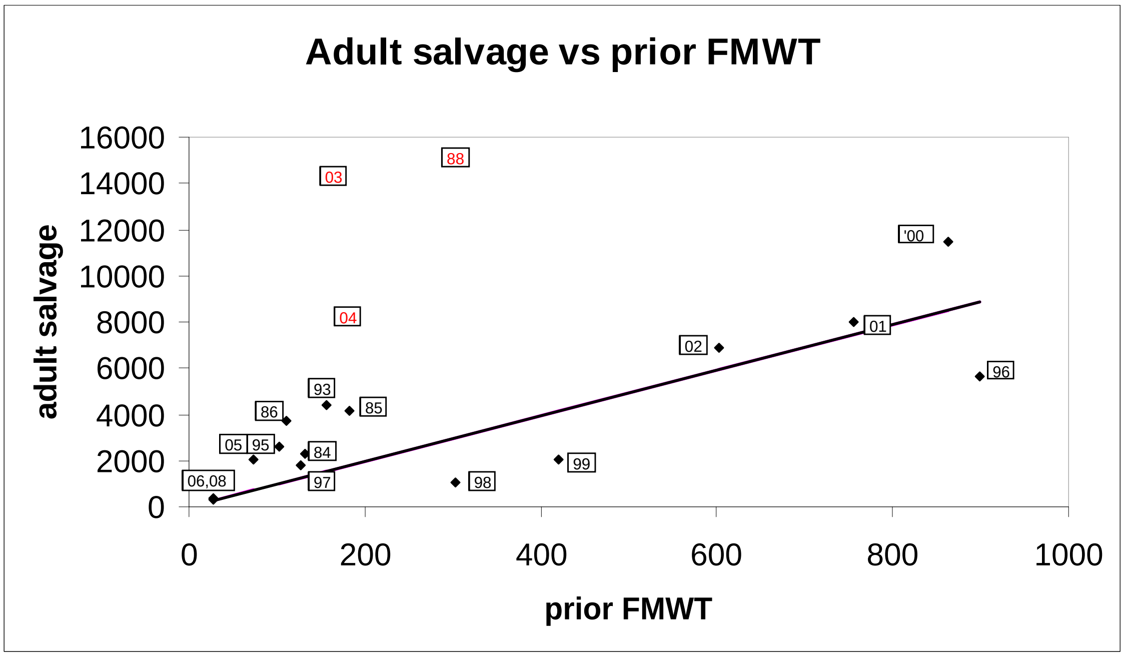


(Note: The steeply increasing linear piece above ***is*** a straight line but not displayed as such due only to a software graphical defect.)

18. As seen in the graph at paragraph 16, the three years with OMR flow more negative than -8000 cfs are 1988, 2003, and 2004—they are also years that had high salvage rates. With flow as an explanation for these salvage rates, I next evaluated whether adult abundance as measured by the prior year FMWT index accounted for changes in the amount of salvage in other years. To do that evaluation, I compared a simple model in which total adult salvage is proportional to the prior year FMWT index (the "proportional model") as against another model in which total adult salvage was independent of FMWT (the "alternative model"). I used a "weight of the evidence" approach to evaluate which model better explained the variation in adult salvage. This approach generates what is known as an "Akaike AICc score" for each model compared. The scores are used as a measure of the weight of the evidence in favor of one model as against another. A lower AICc score means the model better explains the variables being tested. *See* Burnham, K. & Anderson, D., *Multimodel Inference, Understanding AIC and BIC in Model Selection*, 33:2 Socio. Methods & Res. 261-304 (2004).

19. The Akaike AICc score for the proportional model was more than 17.0 below the alternative model. This means that the weight of evidence as measured by Akaike weights was about 100 percent in favor of the proportional model. The data used for this analysis is shown in the table in paragraph 14 above. A graph of salvage versus the prior FMWT shows the strong linear relationship between the two factors (r=0.82, which is statistically significant at p-value < 0.001), again excluding the years 1988, 2003, and 2004. The graph below shows the result that annual salvage has decreased with decreases in annual adult abundance with the exception of years with very negative OMR flows, i.e., less negative than -8000 cfs.



20. Using the weight of evidence approach, I also evaluated the relationship between the population growth rate and both December-March average OMR flows and abundance using the data shown in Appendix Point 1. Two models were constructed. The first model uses abundance as a single explanatory variable ("S only"), and the second model uses both abundance and OMR flows ("OMR & S"). I compared these two models to see whether the model using OMR flows resulted in a better fit to the data. It did not. The results showed that the AICc score for the first model was below the AICc score for the second model, and indicated a 73 percent

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weight of evidence in favor of a model fit that does not include December-March OMR flows. (The result was 71 percent using salvage-weighted OMR flows.)

Dec-Mar OMR	Number of observations	20
Number of Parameters	3	4
	S only	OMR & S
RSS	15.09	14.22
ln(like)	-27.14	-26.55
AIC	60.29	61.09
AICc	61.79	63.76
Delta	0.00	1.97
e^-d/2	1.00	0.37
Weight	0.73	0.27

21. Having now evaluated the data using several different statistical approaches, I again conclude that the level of December-March OMR flows does not have any statistically significant effect on the population growth rate of the delta smelt. With respect to the salvage rate, only December-March OMR flows more negative than -6,100 cfs show any correlation to the salvage rate.

III. RPA COMPONENT 2 – JUVENILES

A. Action 3 Involves Setting OMR Flows During the Larval/Juvenile Life Stage of the Smelt

22. The BiOp's RPA Component 2 is implemented through what is labeled by FWS as "Action 3." Action 3 is designed to commence based on a temperature trigger, or at the onset of spawning, and remains in place until June 30 or when a specific higher temperature is reached, whichever occurs first. Under this Action, FWS limits net daily OMR flow to no more negative than -1,250 cfs to -5,000 cfs based on a 14-day running average with a simultaneous 5-day running average within 25 percent of the applicable requirement for OMR. Specific OMR flows within this range are recommended by the Smelt Working Group depending on certain criteria, including sampling data, salvage data, flows, and turbidity, but FWS makes the final determination.

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B. The Data Does Not Support the Conclusion That Spring OMR Flows Have a Statistically Significant Effect on the Population Growth Rate

23. To evaluate the available data on juveniles, I tested the relationships between April-July salvage-weighted OMR flows and the juvenile salvage rate, and between average OMR flows and the juvenile salvage rate. I included OMR flows for the years 1996-2007 but excluded the years 1995, 1998, and 2006 as those three years had positive average OMR flow. *See* BiOp at 220 (AR at 000235) (excluding 1995 and 1998); Docket #401 at ¶¶ 100-105 (explaining that 2006 had positive average flow). I constructed a juvenile salvage rate index by dividing the total salvage for April-July by the juvenile abundance 20-mm survey index. The 20-mm survey index was not available prior to 1995, preventing the inclusion of more years in this analysis. I relied on data from Table C-4 on page 392 of the BiOp (AR at 000407), as well as daily data provided by FWS in the FOIA response, to construct the following table.

year	Prior FMWT	20-mm index	STNS	juvenile Salvage	salvage/20-mm index Salvage Rate	April-July Average OMR	Salvage weighted average OMR (Apr-Jul)
1996	899	33.9	11.1	40099	1182.86	-4251.57	-3130.94
1997	127	19.3	4	42091	2180.88	-4942.25	-2752.17
1999	420	39.7	11.9	152526	3841.96	-3806.11	-3650.77
2000	864	23.8	8	101783	4276.60	-5494.42	-4707.09
2001	756	11.3	3.5	15984	1414.51	-4310.28	-2319.17
2002	603	8	4.7	59652	7456.50	-5587.61	-2832.55
2003	139	13.1	1.6	26220	2001.53	-6447.81	-5616.60
2004	210	8.2	2.9	12441	1517.20	-6193.22	-5215.33
2005	74	15.4	0.3	1734	112.60	-510.99	168.53
2007	41	1	0.4	2669	2669.00	-3864.97	-4594.10

24. The results indicate that spring OMR is not positively correlated to either salvage rate or salvage using either average OMR flows or salvage-weighted OMR flows. The 20-mm survey index is significantly positively correlated to spring salvage (p-value = 0.007). Spring juvenile salvage is better predicted simply based on abundance than by any measure of OMR flow. Also notable is the significant positive correlation between salvage and the Summer Townet Survey index ("TNS"). The positive correlation means that in years with higher

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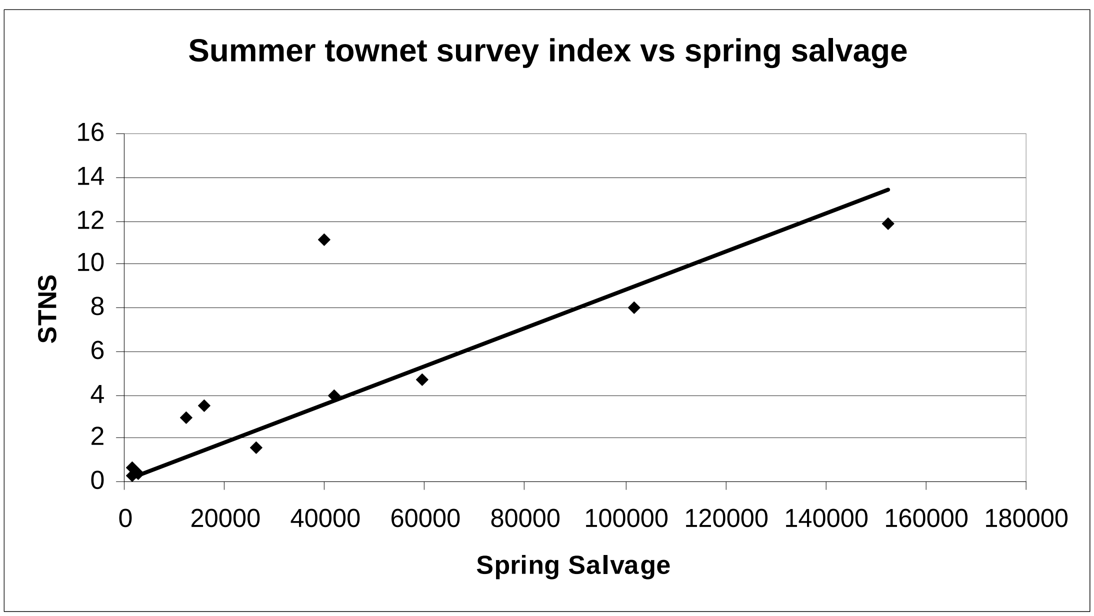
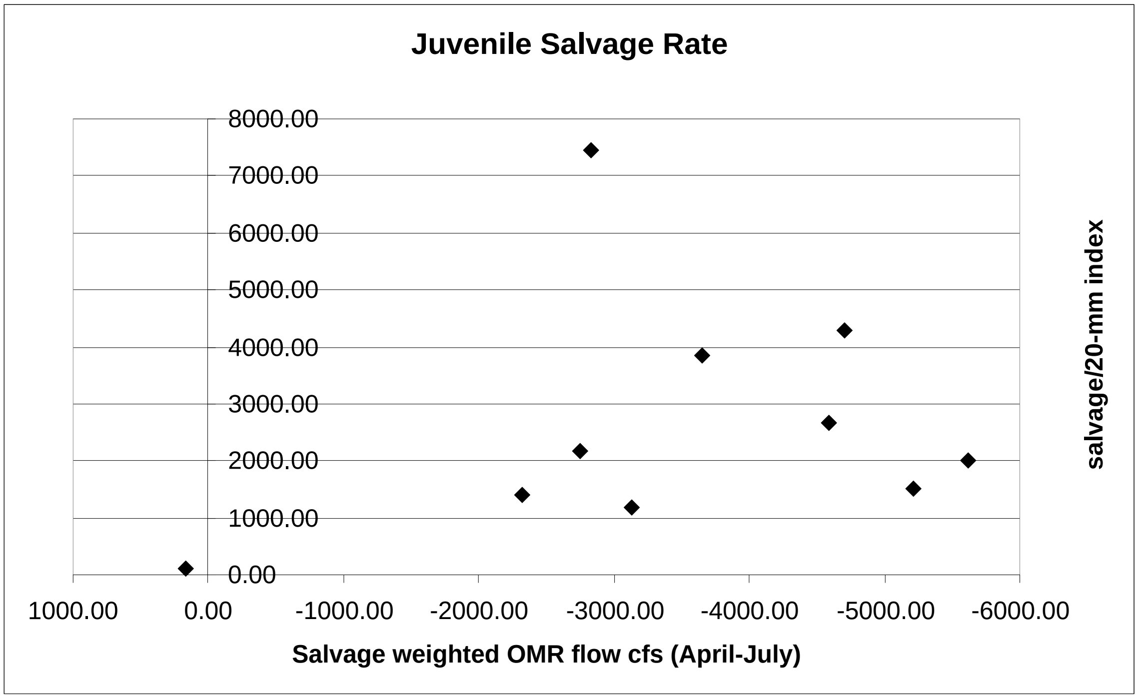
abundance as measured by both the 20-mm index and the TNS, salvage is also higher. The correlations are shown in the table and graph below.

Sample Correlations	*previous FMWT*	*20-mm index*	*STNS*	*Salvage*	*Salvage Rate*	*OMR*	*weighted average OMR (Apr-Jul)*
previous FMWT	1.00						
20-mm index	0.44	1.00					
STNS	0.68	0.89	1.00				
Salvage	0.40	0.74	0.80	1.00			
Salvage Rate	0.30	-0.03	0.27	0.54	1.00		
OMR	-0.20	0.15	-0.12	-0.15	-0.42	1.00	
weighted average OMR (Apr-Jul)	0.01	0.10	-0.10	-0.18	-0.23	0.82	1.00

P-value for one-sided hypothesis test for correlation>0	*previous FMWT*	*20-mm index*	*STNS*	*Salvage*	*Salvage Rate*	*OMR*	*weighted average OMR (Apr-Jul)*
previous FMWT	1.00						
20-mm index	0.099	1.00					
STNS	0.014	0.0003	1.00				
Salvage	0.123	0.007	0.002	1.00			
Salvage Rate	0.201	Na	0.221	0.052	1.00		
OMR	na	0.344	na	na	na	1.00	
weighted average OMR (Apr-Jul)	0.491	0.392	na	na	na	0.002	1.00



25. The next graph shows the data used in the correlation analysis for the OMR and juvenile salvage rate factors. The graph demonstrates visually what the correlation analysis showed; namely, that there is not a positive correlation between OMR flow and salvage rate.

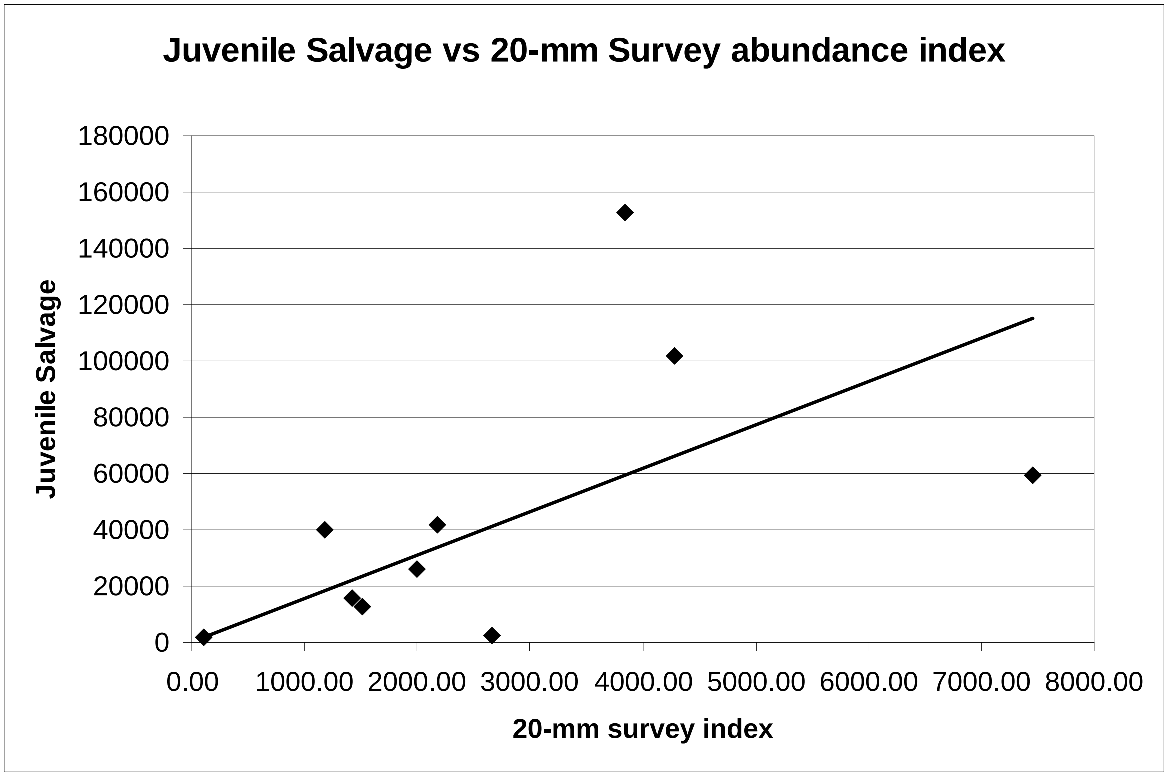


26. I also evaluated the relationship between daily April-July OMR flows and the average daily juvenile salvage rate.[4] The results of my analysis show that the average daily salvage rate varies widely with different OMR flows. In fact, the salvage rate was much lower at -7500 cfs than at -500 cfs. The data does not show any correlation between the two variables.

27. In reviewing the available data, I recognized that the majority of juvenile salvage has occurred in May and June. Therefore, I conducted the same analysis using only May-June OMR flows. The results were similar in that the salvage rate did not increase with progressively more negative OMR flows. Thus, the data does not show any correlation between spring OMR flows and juvenile salvage rate.

[4] The FOIA responses did not provide all of the data needed to perform the analyses in Paragraphs 26 and 27. Daily salvage values for the spring (April through July) were not included; therefore, I obtained these from Metropolitan.

28. The positive relationship between juvenile salvage and the 20-mm survey index can be seen in the figure below.



29. Based on my analysis of the available data for the larval/juvenile life stage of the smelt, OMR flows have had no statistically significant detrimental effect on the population growth rate of the species, nor do OMR flows correlate to salvage at this life stage.

C. Variability From Juvenile to Adult Life Stages

30. I recognize that the data results regarding OMR flows for the larval/juvenile period, and my conclusion in paragraph 29 above, run counter to the management efforts that FWS has developed and is implementing through the BiOp. In these circumstances, an explanation regarding fish population dynamics and variability is instructive.

31. With respect to the delta smelt, the data shows a statistically significant correlation ($r=0.68$; $p\text{-value}<0.001$) between adults (as measured by the FMWT) and their progeny (as

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measured by the TNS for years 1987-2007).[5] The TNS does not then significantly correlate (r=0.34; p-value > 0.05) to the next FMWT (juveniles to adults) and there is considerable variability in that relationship. (In fact, there is variability from adults to juveniles as well.) In my professional experience with fish population dynamics, this phenomenon is due to the variability typically observed in fish populations between those life stages. I have reviewed the literature relied on in the BiOp, and the observations by others confirm this variability exists for the smelt. *See, e.g.*, Bennett, W., *Critical Assessment of the Delta Smelt Population in the San Francisco Estuary, California*, San Francisco Estuary & Watershed Science 26 (2005) ("stockrecruit relationships typically exhibit considerable variability (see Myers and others 1995 for a catalogue of 274 relationships)"). Scientists in this field have observed that there is a 50-fold variability for delta smelt. *See* Kimmerer, W., *Losses of Sacramento River Chinook Salmon and Delta Smelt to Entrainment in Water Diversions in the Sacramento-San Joaquin Delta*, San Francisco Estuary & Watershed Science 1 (2008).

32. On the subject of variability, Bennett makes the following further observations:

> In reality, however, estimating the proportion lost to exports misrepresents their actual impact on the population, especially during years if and when other sources of mortality (e.g. density dependent effects) are important at later life stages. As in many fisheries, estimates of "harvest" by the water export facilities also need to be evaluated in the context of other sources of mortality. In years of high juvenile abundance, density dependent effects may minimize the impact of export losses. For example, even though an estimated 73,380 juveniles were lost during spring 1999 (Nobriga and others 1999), adult abundance later in the year (MWT = 864) was one of the highest recorded since the population declined.

Bennett (2005) at 38. Thus, Bennett's example of 1999 shows that even high juvenile salvage was then followed by one of the highest adult abundance measurements—this well-illustrates the variability that occurs between the larval/juvenile and adult life stages of many fish species.

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[5] The FMWT and TNS are used here because, as the BiOp reports, "The Fall Midwater Trawl Survey (FMWT) and the Summer Townet Survey (TNS) are the two longest running IEP fish monitoring programs that are used to index delta smelt abundance." *See* BiOp at 143 (AR at 000158).

33. I include this explanation because FWS's efforts to establish any correlation between juvenile salvage and subsequent adult abundance (and then trying to control that salvage through OMR flows) ignores the variability at this life stage (a 50-fold variability according to Kimmerer). That the data does not establish such a correlation, as explained through my analyses above, is therefore unsurprising. The large variability could be due to purely natural fluctuations, but it also commends more research on the potential significance of other sources of mortality, such as pollutants and predators.

34. All of the above analyses demonstrate that juvenile salvage does not have a statistically significant negative effect on population growth. This conclusion is consistent with general principles of fish population dynamics, as it is not unusual to see fluctuations in year class abundance caused by factors other than changes in abundance of spawners. This also holds equivalently for eggs, larvae, and juveniles, assuming their abundance is proportional to the abundance of the spawners that produced them. *See* Hilborn, R. & Walters, C., *Quantitative Fisheries Stock Assessment: Choice, Dynamics and Uncertainty*, Chapman & Hall at ch. 7 (1992) (citing references).

I declare under penalty of perjury under the laws of the State of California and the United States that the foregoing is true and correct and that this declaration was executed on December 7, 2009 at Del Mar, California.

Richard B. Deriso

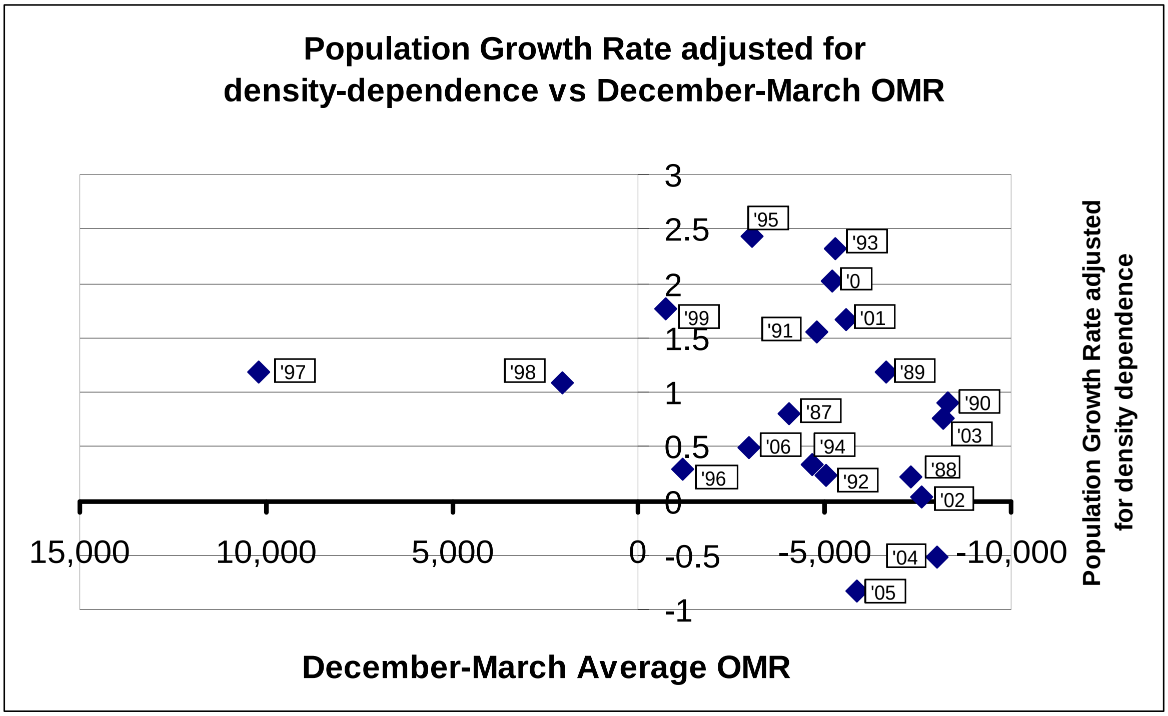
DR. RICHARD B. DERISO

Appendix

Appendix

Appendix 1: Supporting Technical Details to Analyses Described in "Supplemental Declaration of Dr. Richard B. Deriso"

Point 1.



Year	Dec-Mar Average OMR	FMWT year-1 (= FMWT_1)	FMWT year (= FMWT_0)	ln(FMWT_0/FMWT_1)	Population growth rate adjusted for density-dependence
1987	-4054.2	212	280	0.278	0.807
1988	-7319.8	280	174	-0.476	0.223
1989	-6647.8	174	366	0.744	1.178
1990	-8313	366	364	-0.005	0.908
1991	-4775	364	689	0.638	1.546
1992	-5037.4	689	156	-1.485	0.233
1993	-5279.8	156	1078	1.933	2.322
1994	-4656.2	1078	102	-2.358	0.331
1995	-3031.5	102	899	2.176	2.431
1996	-1181.7	899	127	-1.957	0.286
1997	10188.7	127	303	0.870	1.186
1998	2046.5	303	420	0.327	1.082
1999	-740.2	420	864	0.721	1.769
2000	-5178.4	864	756	-0.134	2.022
2001	-5558.7	756	603	-0.226	1.660
2002	-7615.3	603	139	-1.467	0.037
2003	-8161.1	139	210	0.413	0.759
2004	-8004.5	210	74	-1.043	-0.519
2005	-5858.4	74	27	-1.008	-0.824
2006	-2975.7	27	41	0.418	0.485

SUMMARY OUTPUT

ln(FMWT/FMRT_1)=a+b*(Dec-Mar OMR)+c*FMWT_1

Regression Statistics	
Multiple R	0.692
R Square	0.478
Adjusted R Square	0.417
Standard Error	0.915
Observations	20.000

ANOVA

	df	*SS*	*MS*	*F*
Regression	2.000	13.034	6.517	7.792
Residual	17.000	14.218	0.836	
Total	19.000	27.253		

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	1.102	0.377	2.920	0.010
Dec-Mar OMR	0.000	0.000	1.023	0.321
FMWT year-1	-0.002	0.001	-3.705	0.002

The analysis was made by first applying a logarithmic transformation to the Ricker model to obtain equation (3.33) in Quinn and Deriso (1999), which is then treated as a multiple linear regression equation. The equation applied is shown in the table above. The density-dependent term is statistically significant (P-value = 0.002 is below the 0.05 level). December-March Average OMR is not statistically significant (that is, P-value 0.321 is above the significance level of 0.05).