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UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF CALIFORNIA

THE CONSOLIDATED SALMON CASES: SAN LUIS & DELTA-MENDOTA WATER AUTHORITY, *et al.* v. LOCKE, *et al.*	**LEAD CASE NO: 1:09-cv-1053-OWW-DLB** Consolidated With: 1:09-cv-1090-OWW-DLB 1:09-cv-1378-OWW-DLB 1:09-cv-1520-OWW-SMS 1:09-cv-1580-OWW-DLB 1:09-cv-1624-OWW-SMS
STOCKTON EAST WATER DISTRICT v. NOAA, *et al.*	
STATE WATER CONTRACTORS v. LOCKE, *et al.*	**DECLARATION OF DR. RICHARD B. DERISO IN SUPPORT OF PLAINTIFFS' MOTION FOR SUMMARY JUDGMENT**
KERN COUNTY WATER AGENCY, *et al.* v. U.S. DEPARTMENT OF COMMERCE, *et al.*	
OAKDALE IRRIGATION DISTRICT, *et al.* v. U.S. DEPARTMENT OF COMMERCE, *et al.*	Date: November 18-19, 2010 Time: 9:00 a.m. Ctrm: 3 Judge: Oliver W. Wanger
THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA v. NATIONAL MARINE FISHERIES SERVICE, *et al.*	

I, DR. RICHARD B. DERISO, declare:

1. My declaration is set forth in the following manner:

I. Background and Experience

2. I am the Chief Scientist of the Inter-American Tropical Tuna Commission, and I have held this position or the previous position as Chief Scientist of the Tuna-Billfish Program since 1988. *See* Summary Professional Vitae, attached hereto as **Exhibit A**. I have a Ph.D. in Biomathematics (Quantitative Ecology) from the University of Washington, a Master's of Science in Mathematics from the University of Florida, and a Bachelor's of Science in Industrial Engineering from Auburn University. I have been teaching courses in fish population dynamics, quantitative ecology, and related areas for over twenty years. I was an Associate Adjunct Professor at the Scripps Institution of Oceanography, University of California, San Diego, from 1990-2006 and an Affiliate Associate Professor of Fisheries at the University of Washington from 1987-2006. I have also taught several graduate courses, including Theoretical Models of Exploited Animal Populations at the University of Washington, Decision Analysis for Exploited Populations at the University of Washington, and Quantitative Theory of Populations and

Communities at Scripps Institution of Oceanography. I have additional professional experience through a current membership on the Scientific and Statistical Committee of the Western Pacific Regional Fisheries Management Council and a past membership on the Ocean Studies Board which governs the U.S. National Research Council, where I served as co-chairman of the Committee on Fish Stock Assessment Methods. I was also formerly a Population Dynamicist for the International Pacific Halibut Commission. I have been a consultant to several agencies and institutions, both public and private.

3. I have authored or co-authored over 50 publications and reports, including Deriso, R., Maunder, M., and Pearson, W, *Incorporating covariates into fisheries stock assessment models with application to Pacific herring*, Ecol. App. 18(5): 1270-1286 (2008); Deriso, R., Maunder, M., and Skalski, J., *Variance estimation in integrated assessment models and its importance for hypothesis testing*, Can. J. Fish. Aquat. Sci. 64: 187-197 (2007); Deriso, R., *Bayesian analysis of stock survival and recovery of spring and summer chinook of the Snake River basin*, pages 137-56 in J. Berskson, et al. (editors), *Incorporating Uncertainty into Fishery Models*, American Fisheries Society, Symposium 27, Bethesda, MD (2002); and Quinn, T. and Deriso, R., *Quantitative Fish Dynamics*, Oxford University Press (1999). *See* List of Publications, attached hereto as **Exhibit B**.

4. I also have extensive experience evaluating the effects of entrainment on fish populations across the country. For example, I have consulted on the environmental review of once-through cooling systems of nuclear power plants on the Hudson and Delaware Rivers, focusing on impingement and entrainment of fish, with a particular emphasis on their impacts to population. This analysis included modeling, and reviewing models of, the impacts of entrainment and impingement on fish populations. I am also a member of the Estuary Enhancement Program Advisory Committee that reviews the mitigation measures for losses of fish through impingement and entrainment at the Salem Nuclear Power Plant on the Delaware River in New Jersey. With respect to the Columbia and Snake Rivers, I have evaluated both the mortality and related impacts of hydroelectric dam operations on Chinook salmon populations

5. I have personal knowledge of the facts set forth in this Declaration and would competently testify to them if called as a witness.

II. Expert Analysis of the BiOp is Required on Account of the Complex and Technical Nature of the Statistical Analysis

6. I have reviewed the 2009 Salmonid Biological Opinion and Conference Opinion on the Long-Term Operations of the Central Valley Project and State Water Project ("BiOp"), together with portions of the administrative record and papers and studies upon which the BiOp relies. The conclusions set forth in the BiOp are based on complex relationships among a number of factors affecting salmonid populations. For example, the National Marine Fisheries Service ("NMFS") relied on a statistical analysis of the relationship between Old and Middle River ("OMR") flows and adjusted salvage as well as particle tracking model results as well as results from statistical analysis of delta smelt salvage versus OMR flow to justify stringent reasonable and prudent alternatives ("RPAs") imposed on the projects. Understanding the science behind, and the proper use of, the formulas and methods employed in the BiOp is essential to evaluating whether the resultant conclusions drawn by NMFS are scientifically sound or whether they are arbitrary and capricious.

7. I am able to understand and explain the BiOp and draw conclusions from its analyses using my background and expertise in quantitative fish population dynamics. I have experience with the types of quantitative methods a reasonable and qualified scientist would use to evaluate the effects of the projects on salmonids. I am also knowledgeable about the limitations of these methods and the contexts in which they are appropriately used. I understand that the population response of salmonids to a given event is affected by their life cycle, behavioral characteristics, and other biological factors, and that these factors must be accounted for in any statistical analysis of the species.

8. I focused my review on the adjusted salvage and OMR relationship upon which the Delta Division RPAs are in part justified, and specifically Actions IV.1-IV.3, including the Delta Division section of the Effects of the Proposed Action (pages 313-432 of the BiOp).

9. In my review of the BiOp and relevant portions of the administrative record, I discovered several basic flaws in NMFS's methodology and reasoning which cannot be understood or appreciated without explanation by an expert with qualifications similar to mine. I was able to confirm these flaws by interpreting the limited graphs and tables provided in the BiOp, reviewing similar information and studies in the administrative record relied upon by the BiOp, and deciphering the methods that NMFS used.

10. I have also compared NMFS's quantitative analyses against the well-accepted methods of quantitative population analysis that are employed by the scientific community generally, and particularly in the study and management of fish species affected by anthropogenic stressors. My review and comparison revealed that the BiOp frequently did not use standard and well-accepted methods of analysis, but instead relied on analyses that were not biologically and statistically sound and which led to erroneous results.

11. In order to determine whether these erroneous results had a significant effect on the scientific conclusions in the BiOp, I evaluated the same data presented in the BiOp using the standard quantitative analyses employed by fisheries managers. I found that the results of a standard quantitative analyses are fundamentally different from the results reached in the BiOp.

12. Based on the material I reviewed, the fundamental flaws I have identified undermine the jeopardy and adverse modification conclusions in the BiOp and reveal that NMFS had no scientific basis for imposing the RPAs adopted, which are not supported by the best science available.

III. The Quantitative Analysis Performed by NMFS in the BiOp Does Not Follow Standard Fish Population Assessment Methods

A. NMFS's Analysis of the Relationship Between Old and Middle River Flows and Adjusted Salvage Is Flawed Because It Uses Raw Salvage Data

13. The BiOp's analysis of the effects of the projects on salmonids and its conclusion that export and OMR flow restrictions are necessary are based in part on a statistical model of the alleged relationship between OMR flows and an adjusted measure of salvage called "loss." The BiOp includes two figures which depict the relationship between monthly older juvenile loss at the CVP and SWP facilities and monthly average December-April OMR flows. BiOp at 361-62

(Figures 6-65 and 6-66). Based on these figures and the results of particle tracking modeling studies, NMFS concluded that there is a significant relationship between OMR flows and salvage. Thus, the RPAs reduce exports in order to reduce salvage and thereby purportedly to avoid jeopardy to the species. Figures 6-65 and 6-66 are shown below.

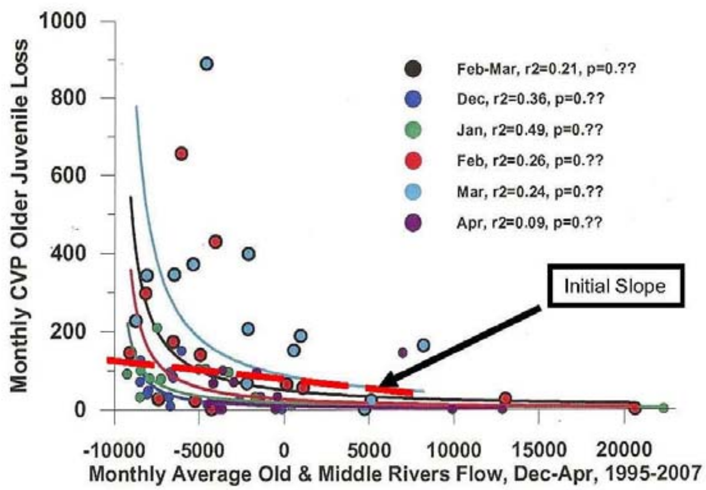

Figure 6-65. Relationship between OMR flows and entrainment at the CVP, 1995-2007 (DWR 2008).

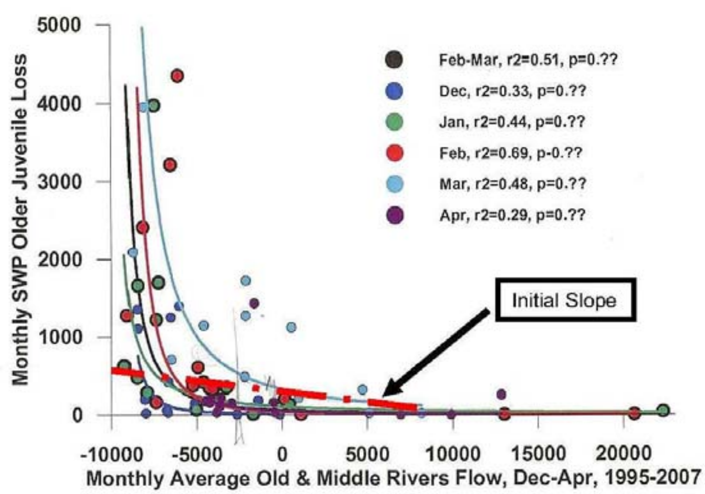

Figure 6-66. Relationship between OMR flows and entrainment at the SWP, 1995-2007 (DWR 2007).

14. In Figures 6-65 and 6-66, NMFS relied on raw salvage numbers as a measure of salmonid loss, rather than a cumulative salvage index or incidental take index. NMFS "expanded" the raw salvage data by adjusting it according to estimates of indirect mortality to

salmonids caused by factors such as predation, loss at the louvers, and the process of collecting, handling, and eventually releasing the fish. However, there is no indication in any of the material that I reviewed that this "expansion" incorporated measures of abundance; instead, it appears to have been a proportional adjustment that increases the raw salvage numbers by a certain predetermined factor. Raw salvage numbers, even when "expanded" in this fashion, do not provide a proper measure of effects to a population in isolation. Such an analysis must take into account the overall size of the population and the *proportion* of the population that is lost to salvage.

15. Using a normalized salvage index instead of raw salvage numbers is the proper approach to analyzing population effects, because it allows a basic assessment of whether the stressor in question has a significant population-level impact on the species. This approach accords with standard principles of fisheries population assessment. *See* Declaration of Dr. Richard B. Deriso, Docket #401, *The Delta Smelt Cases*, No. 1:09-cv-407-OWW (E.D. Cal.) ("Smelt Declaration") at ¶ 14-15, 55-57 (explaining the application of this approach). Generally speaking, a normalized salvage index represents the raw salvage number divided by the total size of the fish population. It is the appropriate measure of the significance of a mortality event on an overall population because it puts the mortality event within the context of the total population abundance.

1. Salvage Data Normalized Using the Incidental Take Index for 2000-2007

16. In this case, I used a normalized salvage index, defined as the Incidental Take Index, is calculated as salvage divided by the measured abundance of the salmon population. I used the data on daily winter-run and spring-run chinook salmon estimated salvage ("Incidental Take"), which are given at the Bureau of Reclamation website http://www.usbr.gov/mp/cvo/fishrpt.html. The data for untagged salmon were summarized into monthly estimates, and then each of the monthly estimates was divided by the corresponding parental escapement. The resultant normalized estimates are defined as the juvenile salmon incidental take index, which represents the direct salvage losses of juvenile salmon adjusted for

parental run size. Unlike the BiOp, I did not apply an expansion factor to account for other direct losses. The vast majority of estimated salvage losses for the winter run occurs during months December through March, whereas the vast majority of estimated salvage losses for the spring run occurs during months March through June.

17. In my previous declaration in this case, I used incidental take data that had been averaged by year. *See* Corrected Declaration of Richard B. Deriso in Support of Metropolitan Water District's Joinder in Motion for Temporary Restraining Order, Docket #271 ("TRO Declaration") at ¶¶ 6-11. In the analysis I prepared for this declaration, I expanded the analysis by using monthly data, as did the BiOp in Figs. 6-65 and 6-66.

18. To determine whether there is a statistically significant relationship between the incidental take index and various measures of OMR flow, I plotted several graphs depicting different aspects of the issue. The first graph, Figure 1, compares the winter run monthly incidental take index against the corresponding monthly average OMR flow. The graph shows that there is not a significant correlation between the monthly OMR flow and incidental take, as is apparent from the very low R^2 value.[1]

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[1] In general R^2 values below about 0.13 are considered to show a lack of statistical significance (p-value>0.05) for sample sizes of 31 and below, which encompasses the results in this declaration.

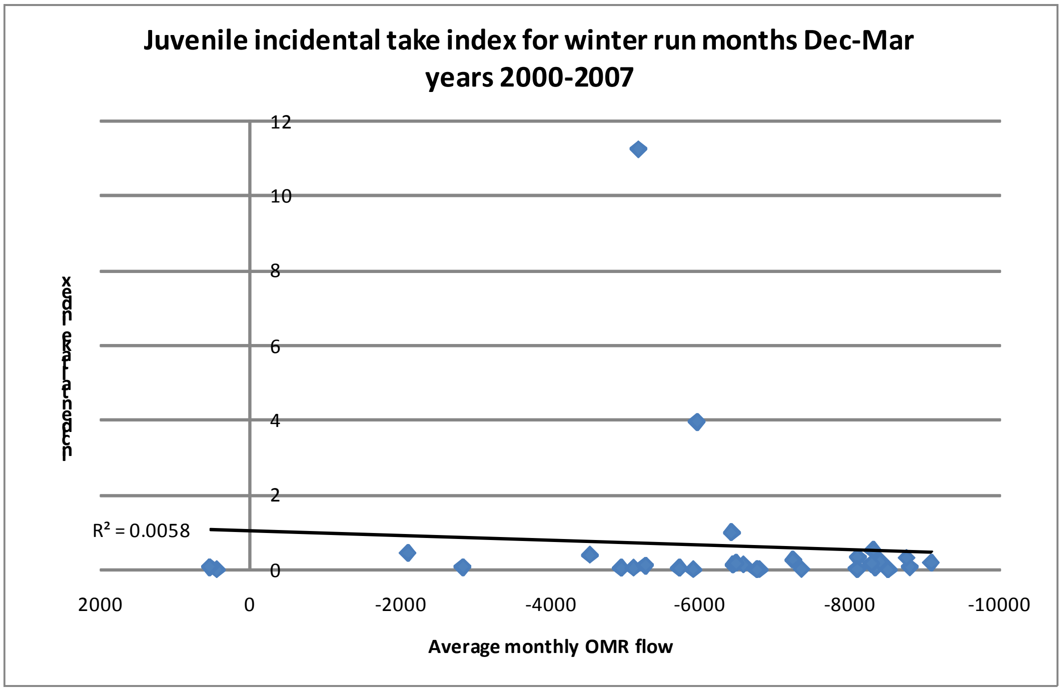

Figure 1

19. As is clear from a visual examination of Figure 1, two months of exceptionally high incidental take index occurred in February and March of 2001. In order to determine whether these exceptional data points affected the result and obscured an otherwise significant relationship, I repeated the analysis while omitting those two data points. The result, Figure 2, depicts the same data shown in Figure 1 except without the two high incidental take index data points. Despite this modification, the correlation remains insignificant as evidenced by the very low R^2.

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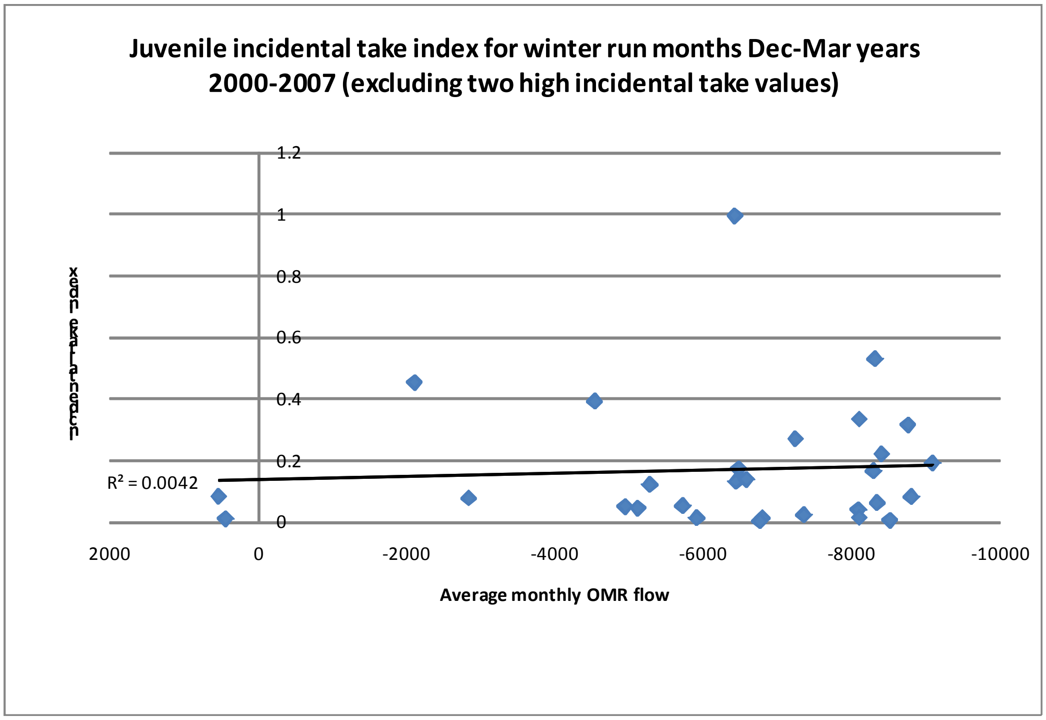

Figure 2

20. In the next graph, Figure 3, I graphed the spring run monthly incidental take index against the corresponding monthly average OMR flow. Here as well, there is not a significant correlation between the OMR flow and incidental take.

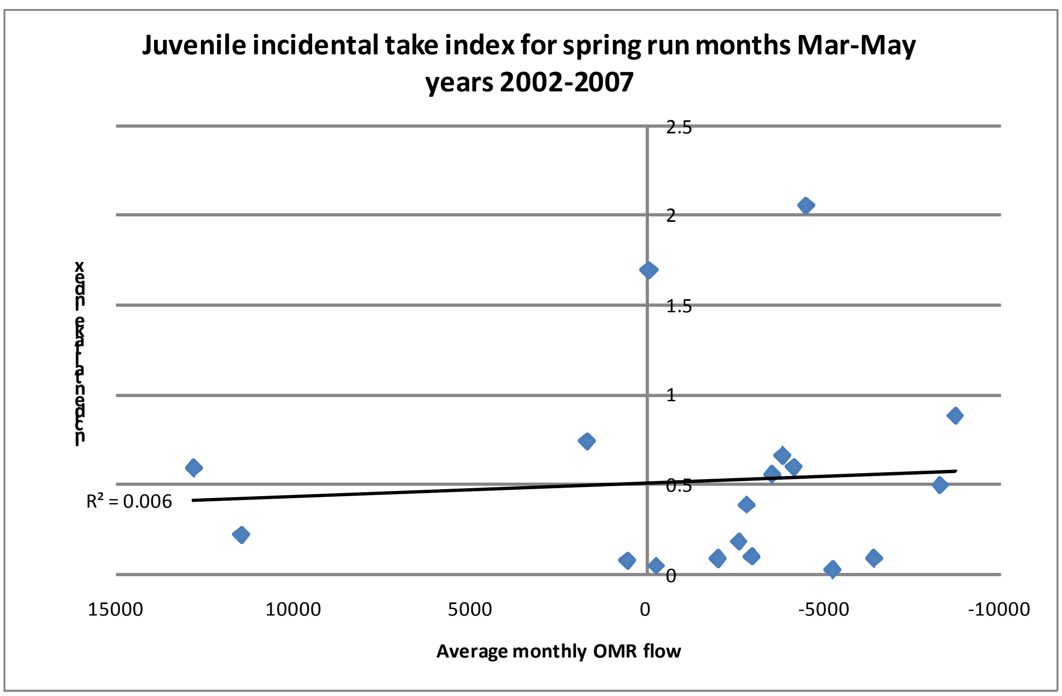

Figure 3

21. In Figures 4 and 5, I graphed the monthly incidental take index for the winter-run chinook against the monthly export to inflow (E:I) ratio. In Figure 5, I repeated the prior analysis of the results of excluding the two months with exceptionally high incidental take index in order to see if they were masking a significant relationship. However, the result was the same for both analyses: there are very low correlations in both Figures 4 and 5 and there is not a significant relationship between E:I ratio and winter run monthly incidental take index.

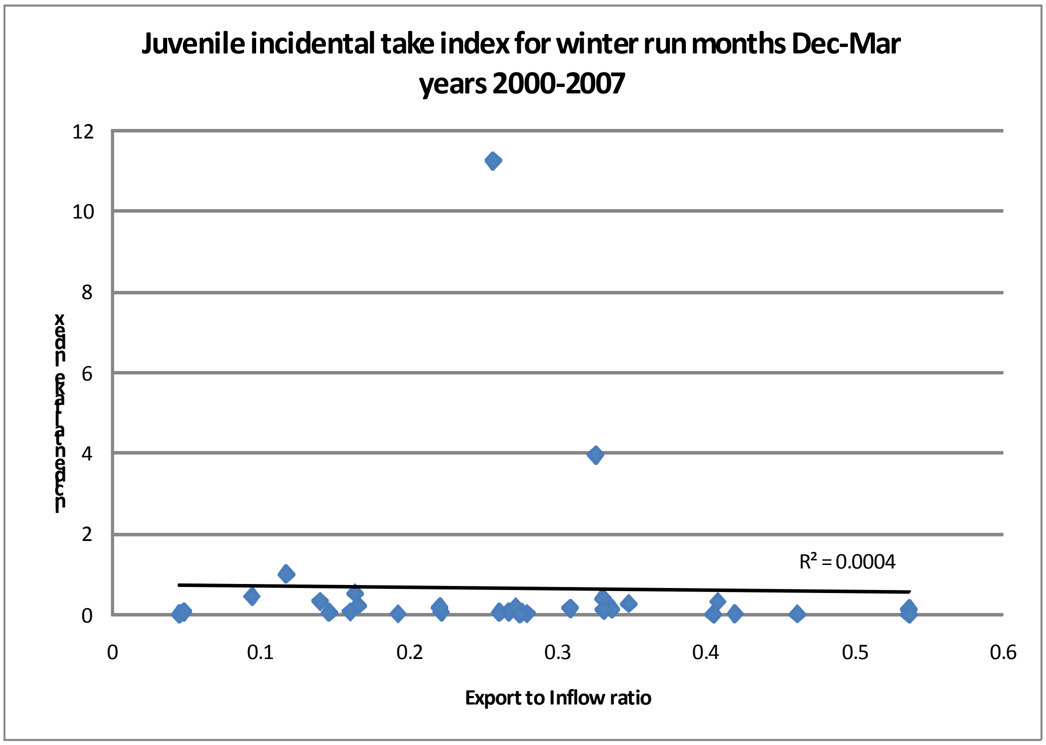

Figure 4

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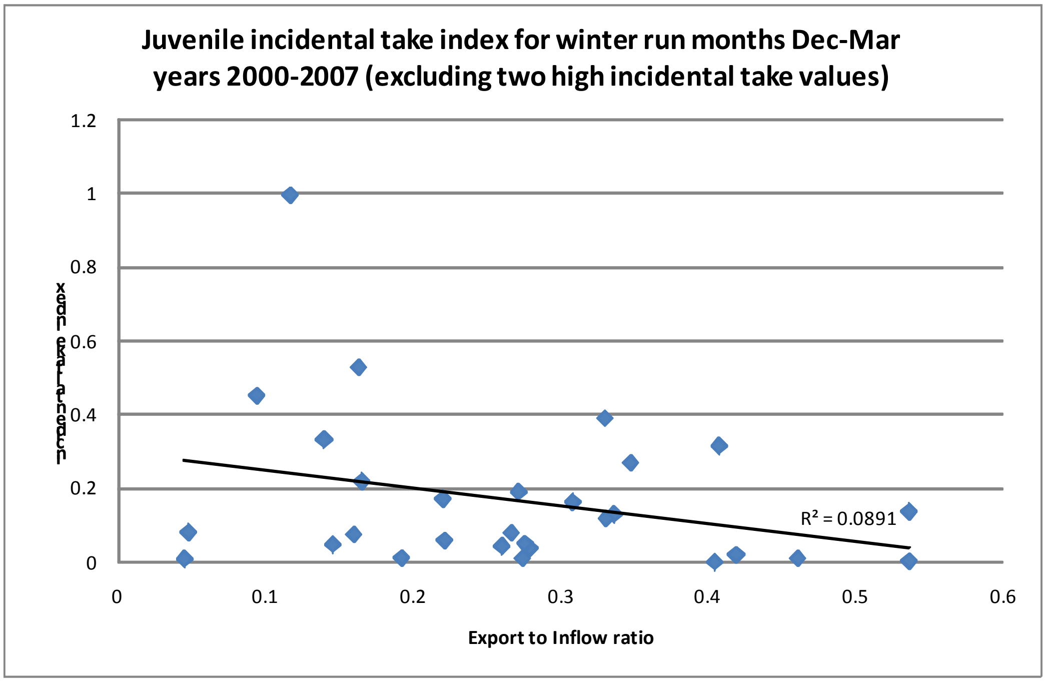

Figure 5

22. Finally, in Figure 6, I graphed monthly spring run incidental take index versus the E:I ratio. Here, also, there is not a significant relationship, as evidenced by the very low R^2.

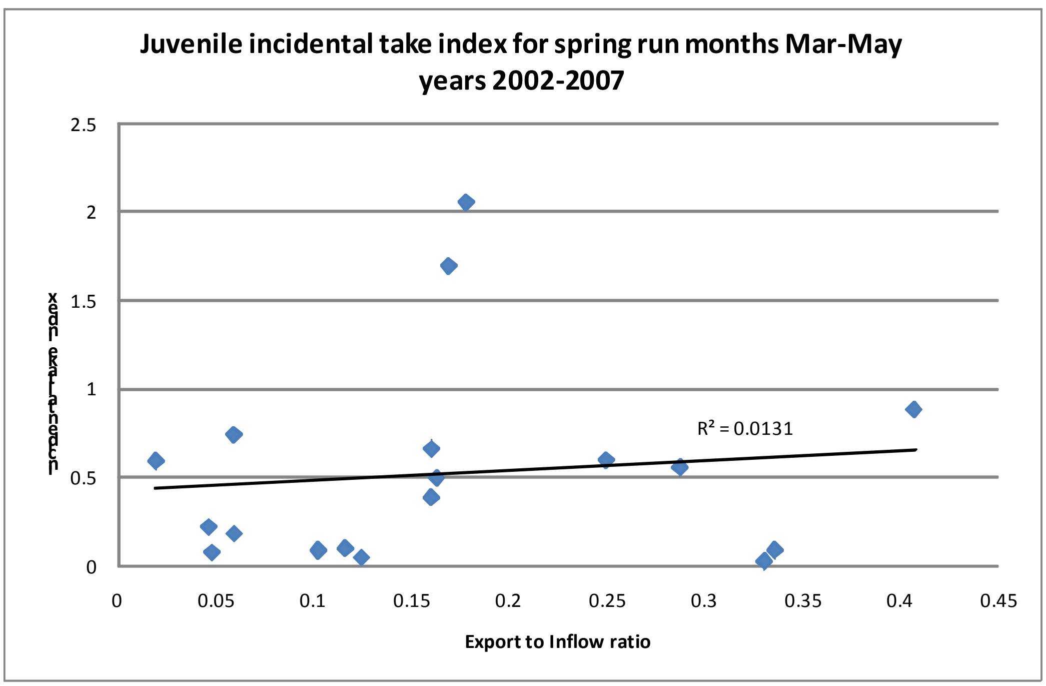

Figure 6

23. These figures, along with the figures in my previous declaration, indicate that there is no statistically significant relationship between OMR flow or E:I ratio and the incidental take index regardless of whether yearly or monthly data is used.

2. Salvage Data Normalized Using the Percent Adjusted Incidental Loss for 1993-2007

24. In the discussion below, I extend my previous analysis in two important ways: first, I use a time series of data that extends the winter run juvenile losses from 1993 to 2007—seven more years of data than in the previous analysis. Second, I replace the incidental take index by an estimate of the percent of winter run juveniles (including both natural and hatchery fish) that are incidentally lost each year. Finally, I calculate the adjusted incidental loss against December-March OMR flow and E:I ratio. Most of the data I used for the analysis was sourced from tables in the BiOp itself, and all of it was available to NMFS at the time of the BiOp.

25. Below is the table summarizing the data, along with explanatory notes describing the data sources:

Year	Population Estimate	Natural Juvenile Production Estimate	Hatchery releases with adipose clip	Juvenile production including adipose clipped hatchery releases	Winter run adjusted incidental loss including adipose clipped fish	Dec-Mar average OMR flow	Dec-Mar E/I ratio	Percent adjusted incidental loss
1986	2,596							
1987	2,186							
1988	2,885							
1989	696							
1990	433							
1991	211	40,100		40,100				
1992	1,240	273,100		273,100				
1993	387	90,500		90,500	1,922	-5,280	0.162	0.70%
1994	186	74,500		74,500	1,004	-4,656	0.361	1.11%
1995	1,297	338,107		338,107	1,351	-3,032	0.071	1.81%
1996	1,337	165,069		165,069	7,611	-1,182	0.113	2.25%
1997	880	138,316		138,316	518	10,189	0.044	0.31%
1998	3,002	454,792	153,236	608,028	2,886	2,046	0.037	2.09%
1999	3,288	289,724	30,755	320,479	4,173	-740	0.092	0.69%
2000	1,352	370,221	165,860	536,081	8,307	-5,178	0.145	2.59%

Year	Population Estimate	Natural Juvenile Production Estimate	Hatchery releases with adipose clip	Juvenile production including adipose clipped hatchery releases	Winter run adjusted incidental loss including adipose clipped fish	Dec-Mar average OMR flow	Dec-Mar E/I ratio	Percent adjusted incidental loss
2001	8,224	1,864,802	251,410	2,116,212	23,392	-5,559	0.353	4.36%
2002	7,441	2,136,747	232,534	2,369,281	10,048	-7,615	0.271	0.47%
2003	8,218	1,896,649	218,547	2,115,196	29,551	-8,161	0.262	1.25%
2004	7,701	881,719	167,271	1,048,990	26,591	-8,005	0.200	1.26%
2005	15,730	3,556,995	173,245	3,730,240	5,337	-5,858	0.282	0.51%
2006	17,205	3,890,534	194,635	4,085,169	3,853	-2,976	0.084	0.10%
2007	2,488	1,100,067	71,846	1,171,913	5,332	-6,234	0.34385	0.13%
2008	2,850	1,152,043	146,189	1,298,232	6,901			

Notes:

- Columns 1-3 were taken from Table 4-2 in BiOp at Page 83.
- The NMFS-Calculated Juvenile Production Estimate in Column 3, which was taken from Column 6 of Table 4-2, appears to represent naturally spawned salmon only.
- Hatchery release numbers (Column 4) were obtained from the Regional Mark Information System Database, updated continuously since 1977. Portland (OR): Regional Mark Processing Center, Pacific States Marine Fisheries Commission. *See* http://www.rmpc.org .
- Juvenile Production (Column 5) is the sum of the preceding two columns, Natural Juvenile Production Estimate and Hatchery Releases.
- The adjusted incidental loss estimates in Column 6 are taken from Table 13-6 in BiOp. BiOp at 775.
- The OMR flow data, Export (E) data, and Inflow (I) data in Column 7 and 8 was provided to MWD via a FOIA request to USFWS (delta smelt request).
- The percent adjusted incidental loss, Column 9, is based on the ratio of adjusted incidental loss to juvenile production including hatchery releases.
- Column labeled "year," Column 1, represents the brood year for the juvenile production estimates and escapement (Columns 2-5); otherwise "year" represents the year of juvenile loss as reported in Table 13-6 of the BiOp at page 775. For example, the percent loss for 1993 (0.70%) is calculated by dividing 1993 incidental loss (1,922 juveniles) (Column 6) by the 1992 brood year production (273,100 juveniles) (Column 5, one row up).

26. Several features of this data set are immediately apparent without any quantitative analysis. First, the percent adjusted incidental loss (Column 9) is never more than 5% of juvenile production (Column 5), and for all but one year is less than 3%. Second, the chart illustrates why it is important to use a normalized abundance index to analyze loss. For example, the 2004

incidental loss was the highest recorded (29,551) and yet this only represented 1.25% of the juvenile production (2,369,281). For comparison, the adjusted incidental loss for 2000 was only a third of that amount (8,307), and yet it represented a 2.59% loss—roughly twice the population-adjusted figure. Without factoring measures of population abundance into the analysis, the significance of these data points would be unclear.

27. Next, I proceeded to analyze the percent adjusted incidental loss against the OMR flow data. In Figure 7, I compared the adjusted incidental loss against yearly averaged OMR data. Thus, for example, the 1993 percent adjusted incidental loss is compared to the December 1992 through March 1993 average OMR flow. The regression line does not differ in a statistically significant way from a horizontal line, indicating that there is not a significant relationship between percent adjusted incidental loss and OMR flow.

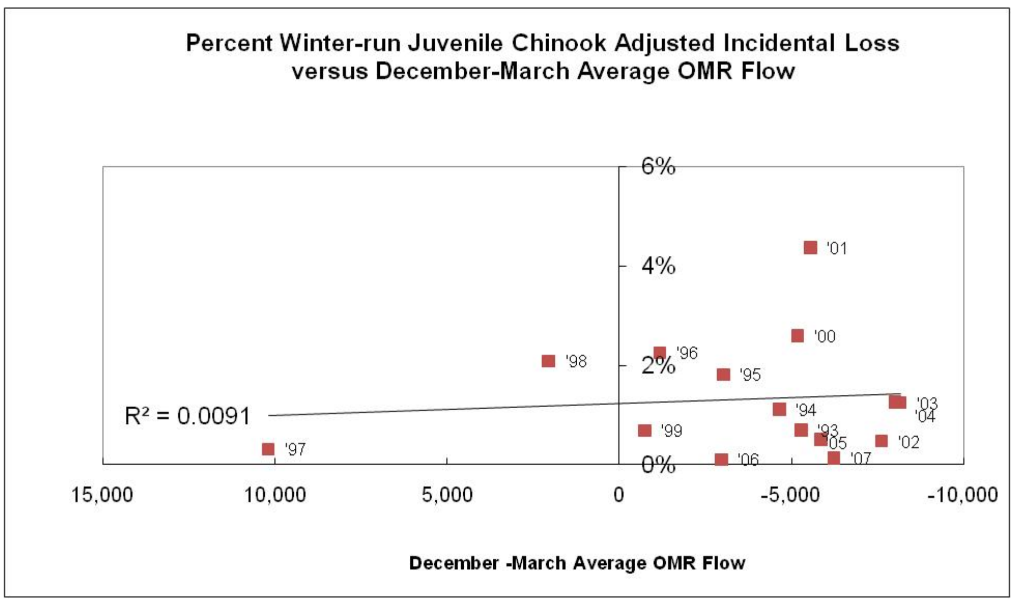

Figure 7 (Year shown is the brood year for each salmon cohort)

28. In Figure 8, I compared the adjusted incidental loss against yearly averaged E:I data. Thus, for example, the 1993 percent adjusted incidental loss is compared to the December 1992 through March 1993 average E:I ratio. Once again, the regression line does not differ in a statistically significant way from a horizontal line, indicating that there is not a significant relationship between percent adjusted incidental loss and E:I ratio.

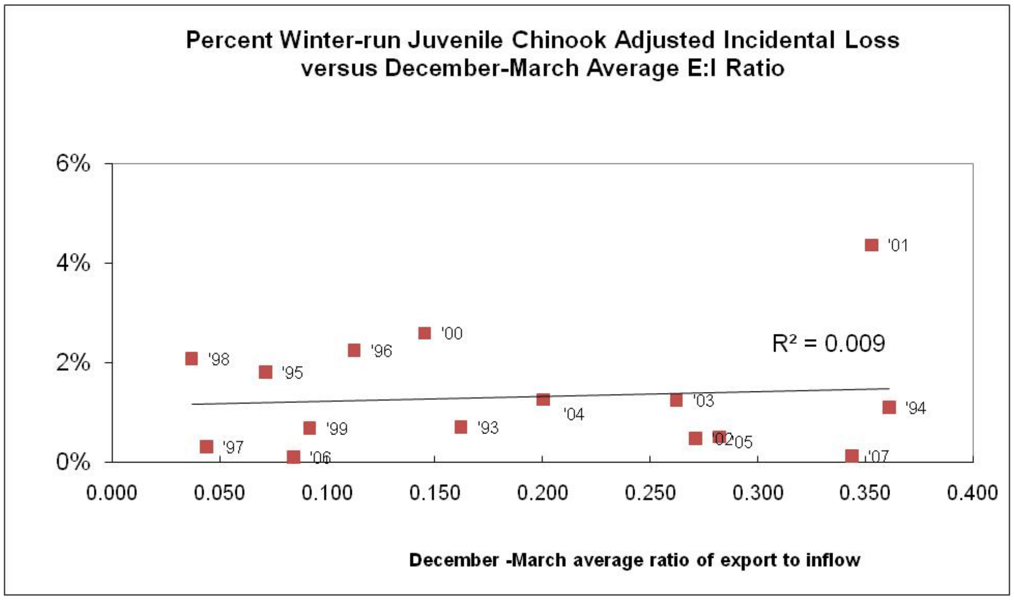

Figure 8 (Year shown is the brood year for each salmon cohort)

3. Salvage Data Normalized Using the Winter-Run Juvenile Production Estimate

29. In my final analysis of normalized salvage data, I used data on daily winter run chinook salmon estimated loss (Incidental Take), which are given at the Bureau of Reclamation web site http://www.usbr.gov/mp/cvo/fishrpt.html. I summarized the loss data into monthly estimates and then divided those monthly loss estimates by the corresponding juvenile production estimate ("JPE"), which is the final column in Table 4-2 of BiOp.[2] BiOp at 83 The main advantage of the juvenile production estimate over escapement as a measure of juvenile production is that the JPE incorporates estimates of sex ratio in order to derive an estimate of female escapement. However, the downside is that the sex ratio estimates are quite different between the carcass survey and the RBDD estimates (which are the two methods used to estimate population in Table 4-2), which may effect the value of the data. The resultant estimates are defined as the percent juvenile salmon incidental take (also known as the percent juvenile salmon salvage) and they represent direct winter-run salvage losses adjusted for juvenile salmon population size.

[2] No corresponding juvenile production estimate for spring run chinook is provided in the BiOp.

30. In Figure 9, the winter run monthly percent incidental take is graphed versus the corresponding monthly average OMR flow. There is not a significant correlation between the OMR flow and incidental take as seen from the very low R^2.

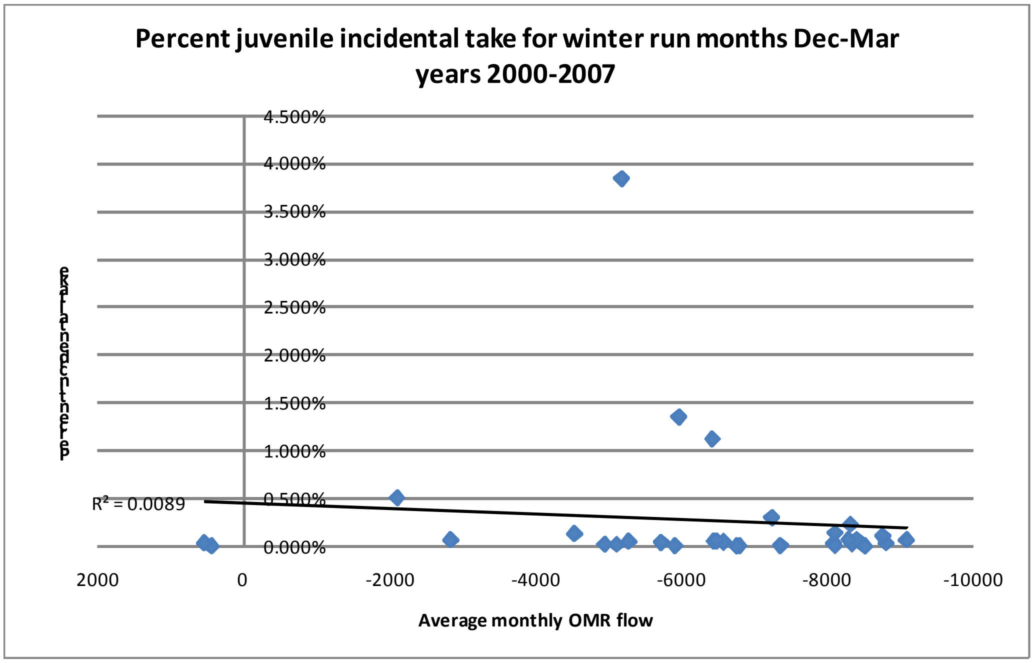

Figure 9

31. In Figure 10, I removed the two months of exceptionally high incidental take index that occurred in February and March 2001. Figure 10 is the same data shown in Figure 9 except the two high take index data points were removed; the correlation remained insignificant as seen by the very low R^2.

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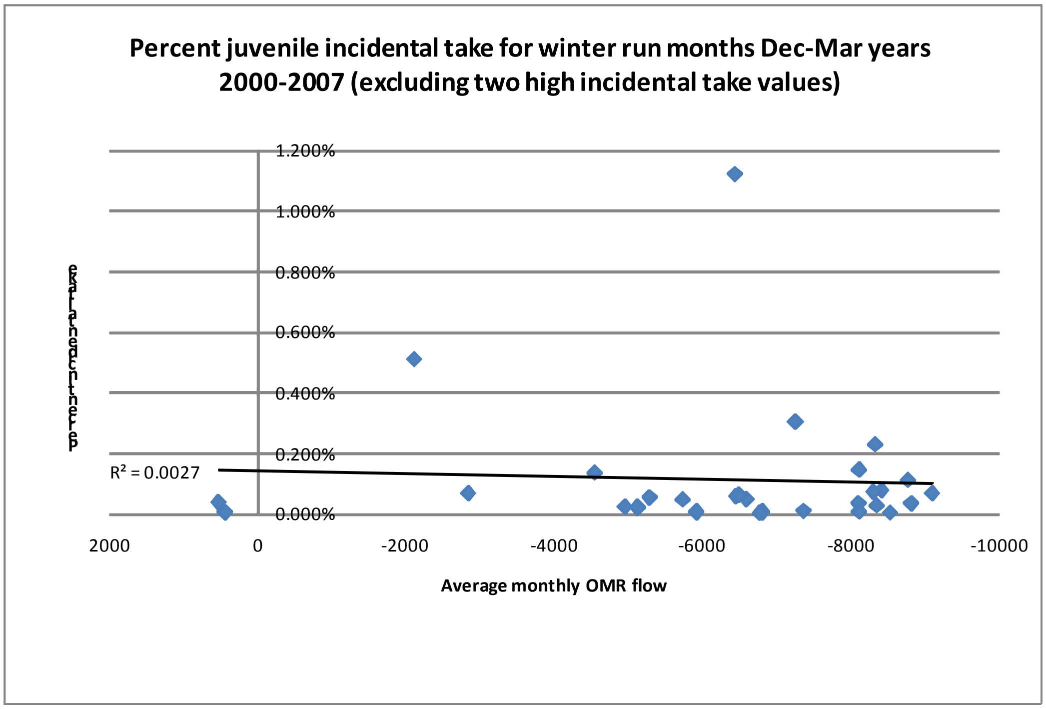

Figure 10

32. Figures 11 and 12 show the monthly percent incidental take for the winter run graphed versus monthly export to inflow (E:I) ratio. Figure 12 once again excludes two months with exceptionally high incidental take index. There are very low correlations in Figures 11 and 12 showing that there is not a significant relationship between E:I ratio and winter run incidental take index.

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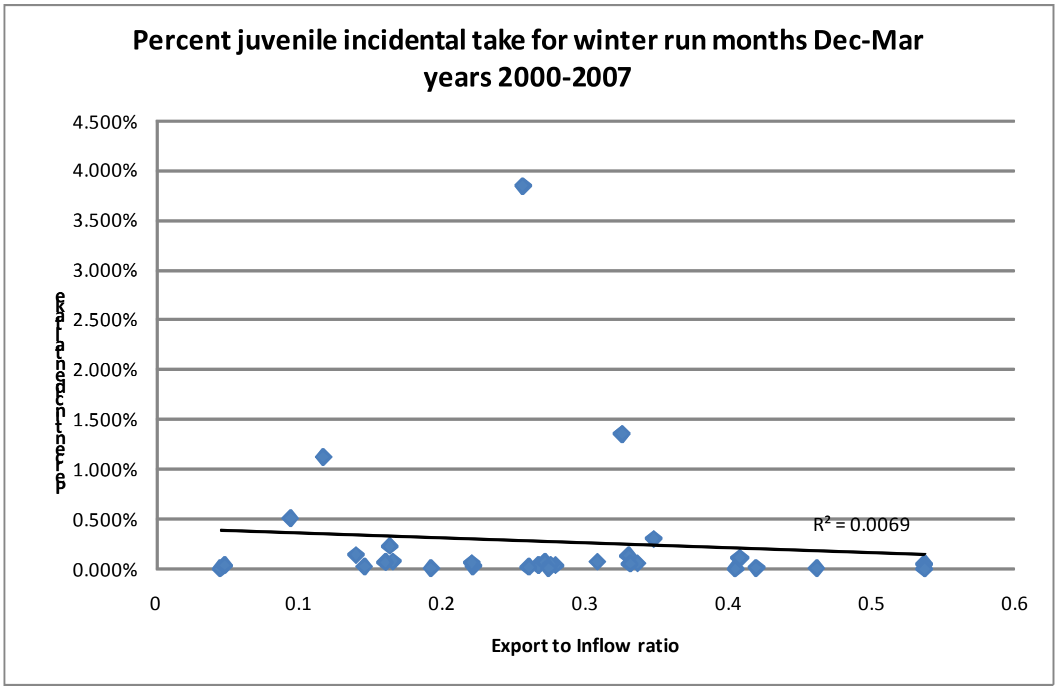

Figure 11

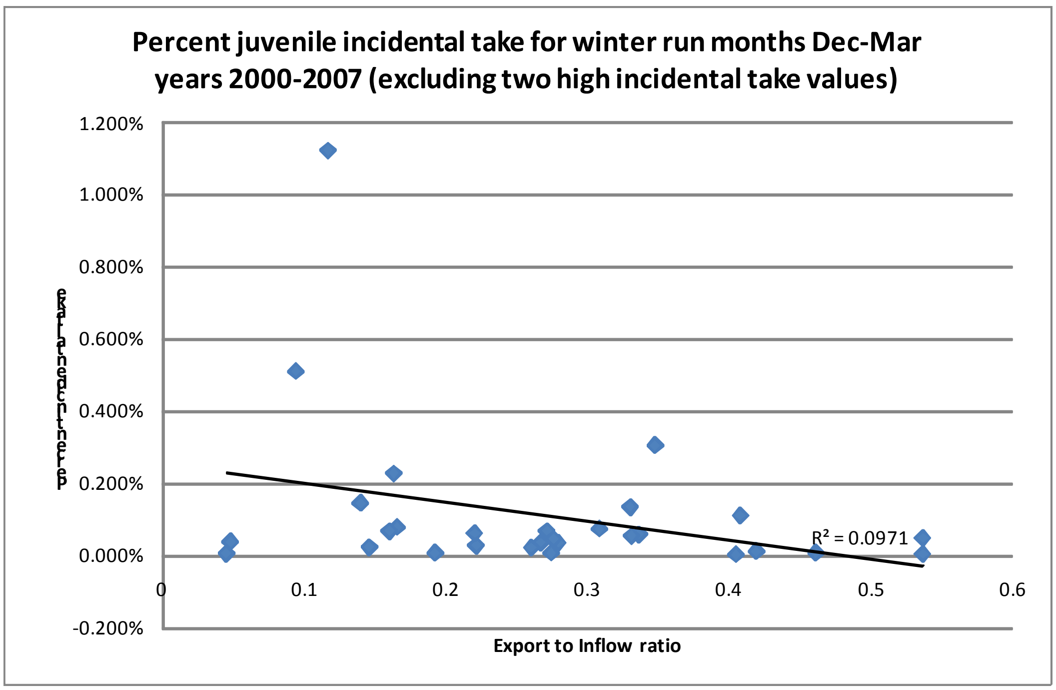

Figure 12

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B. The BiOp Did Not Evaluate the Effect of the Projects on Salmonid Abundance from Year to Year Using the Population Growth Rate

33. Given the substantial quantity and quality of the salmonid population measurements available to NMFS, it would have been standard scientific practice for NMFS to use that data to determine whether the projects were having a measurable impact on the salmonid population growth rate from year to year. This kind of calculation is one of the most basic tools for the management and study of fish populations because it enables managers to determine whether a stressor is having an impact on the population of a species from one generation to the next in the context of its full life cycle, rather than focusing exclusively on isolated mortality events at a single stage of the life cycle. In other words, a population growth rate approach—also known as a quantitative life cycle analysis—allows for the consideration of another dimension of the existing data by showing whether the observed mortality events that take place in given individual years are actually having an effect on population levels over time, from one year to the next. I discuss the population growth rate in more depth in my previous declaration for the delta smelt. *See*, Declaration of Dr. Richard B. Deriso, Docket #401, Consolidated Smelt Cases, 09-cv-00407-OWW-DLB ("Smelt Declaration") at ¶¶ 66-70.

34. The salmonid abundance data cited in the BiOp is fairly robust. For example, Table 4-2 of the BiOp and Table 4-5 of the BiOp, at pages 83 and 97, provide population data going back to 1987 for both winter-run and spring-run chinook. These tables provide adequate data for calculating a population growth rate and then analyzing it using one of the standard growth rate equations, such as the Ricker model. In fact, the BiOp took the first step in this direction by calculating the cohort replacement rate (Table 4-2, Column 4; Table 4-5, Column 6 and 9), which is a measure of population growth rate. As NMFS indicated in the BiOp, the cohort replacement rate is similar to the spawner-to-recruit ratio, or "SRR," which was recommended by the independent Peer Review of the BiOp as an appropriate measure of population-level effects. AR 89612. As the Peer Review stated, "[The SRR] is the most common measure of population productivity and *is the basis* of many population viability analyses that are used to assess the risk of extinction." *Id.* (emphasis added). Having already calculated a population growth rate, such as

the cohort replacement rate, it would have been a small matter for NMFS to take the next step and use the results in a standard Ricker model, or another similar population growth rate formula. However, in my review of the BiOp, I found that NMFS, having undertaken the process of calculating a population growth rate for winter-run and spring-run chinook, in the form of the CRR, never utilized the CRR in a quantitative analysis as the Peer Review suggested.

35. It is unclear why NMFS never used the CRR data set that they developed in the BiOp as an input to a standard population growth rate formula. A population growth rate formula, such as the Ricker model, takes one data set, such as OMR flow measurements, and determines the degree to which that data set correlates with the population growth rate. In other words, it determines how well a set of data can be used to explain the observed variation that takes place in another set of data, namely the population growth rate. This kind of information is essential to the management of a fish population because it allows for a quantitative assessment of which stressors are having a greater or lesser effect on the species and provides guidance on where to focus conservation measures to promote the recovery of the species.

36. In my review of the quantitative analyses in the BiOp, I found that NMFS never performed this basic procedure to determine whether the data shows a correlation between water OMR flow and changes in the salmon population growth rate. As noted above, sufficient population data to perform such an analysis was available to NMFS, and NMFS took the first step of calculating the population growth rate. However, NMFS did not run the results through a standard population growth rate formula, such as the Ricker model. It is difficult to understand why NMFS would not have taken this basic mathematical step of analyzing the data using standard quantitative techniques.

37. Instead, it appears that the BiOp effectively ignored the population data that was available in their quantitative analyses of exports and flow. For example, NMFS used the population data in Tables 4-2 and 4-5 to determine, correctly, that winter-run and spring-run chinook populations have declined in the past several years. However, NMFS never took the basic mathematical step of inputting the data from Tables 4-2 and 4-5 into a standard population growth formula to determine if the data showed that the operation of the water projects was

correlated with that decline over time. Instead, NMFS calculated whether there was a correlation between adjusted raw salvage and OMR flows at a single point in the salmonid life cycle. As described above, this was an improper analysis because it did not scale the adjusted salvage to the population data, and thus determine whether the salvage was affecting the population at that time. In addition to being an improper analysis, it was an incomplete analysis, because it did not determine whether the mortality caused by pumping was affecting the population *over time*, not just at that moment. The standard procedure would be to use a population growth rate formula to determine whether the data shows any relationship between water exports and salmonid population growth rate over time.

1. Winter-Run Chinook Population Growth Rate Analysis

38. In order to elucidate what NMFS would have done had it performed this standard calculation, and to assess what the data would have shown, I ran the population data for winter-run chinook listed in Table 4-2 (Column 2, "Population Estimate") on page 83 through a Ricker stock-recruitment analysis. I used the same three-year time lag to calculate the population growth rate as was used in the BiOp. *See* BiOp at 83, Table 4-2, n.b (explaining that "[t]he majority of winter-run spawners are three years old. Therefore, NMFS calculated the CRR using the spawning population of a given year, divided by the spawning population 3 years prior.").[3] I included December-March average OMR flow as a covariate variable to see whether the data shows that OMR flows explain the observed variation in winter-run chinook population growth rate.

39. The results of the analysis indicate that there is not a statistically significant correlation between the OMR flow data and the winter-run chinook population growth rate.[4] The OMR flow variable had a P-value of 0.501, far from the 5% benchmark, which is the standard for determining statistical significance. *See* Smelt Declaration, Docket #401, at ¶ 72. I graphed these

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[3] In both my winter-run and spring-run analyses, I used the standard stock-recruit method of calculating population growth rate, which takes the logarithm of the cohort replacement rate. The results are proportional to the CRR, so any trends in the data will be the same. As the BiOp notes, the CRR and stock-recruitment rates are similar. BiOp at 82.

[4] For more details on the analysis please see Appendix.

results in Figure 9b below, which plots the population growth rate against December-March average OMR flow. As is apparent from the figure, there is no relationship between population growth rate and OMR flow.

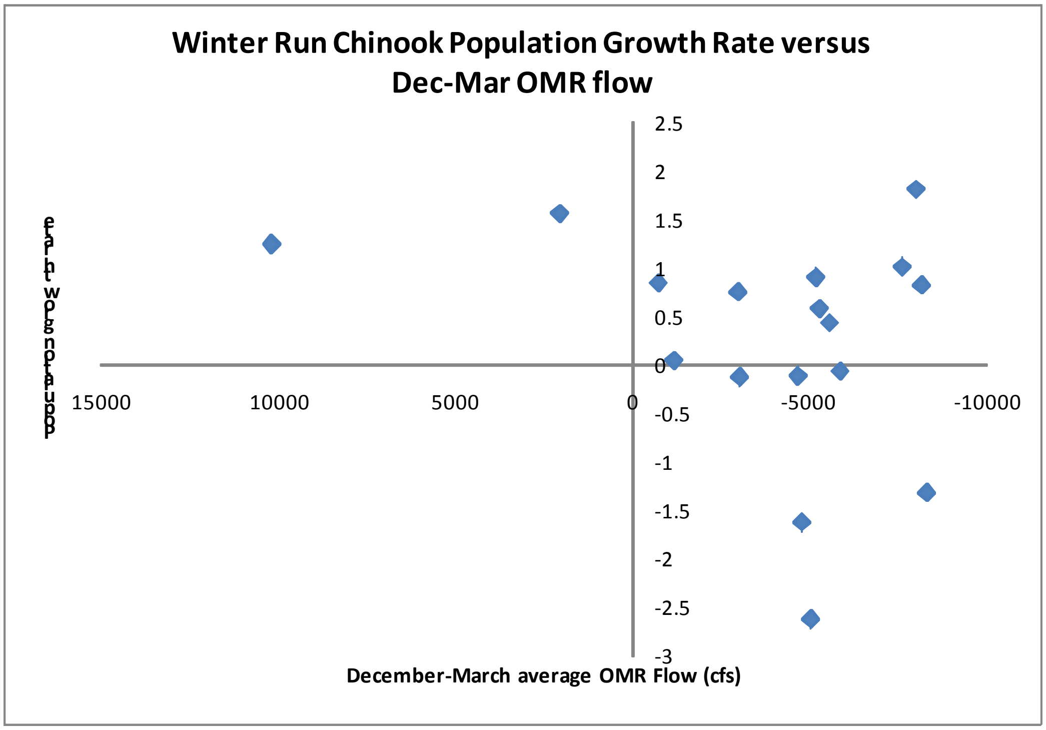

Figure 9b

2. Spring-Run Chinook Population Growth Rate Analysis

40. I performed a similar analysis for spring-run chinook, using the population growth rate calculated from Table 4-5, using the same 3-year lag as the BiOP. *See* BiOp at 97, Table 4-5, n.c (explaining that "[t]he majority of spring-run spawners are 3 years old. Therefore, NMFS calculated the CRR using the spawning population of a given year, divided by the spawning populations 3 years prior."). Once again, I included average OMR flow, this time for March-June, as a covariate to see whether the data shows that OMR flows explain the observed variation in spring-run chinook population growth rate. As before, the data shows that the relationship between OMR flow and the population growth rate is not statistically significant (P-value = 0.26). Figure 10b graphs average OMR flow and population growth rate, and shows no relationship

between the two variables.[5]

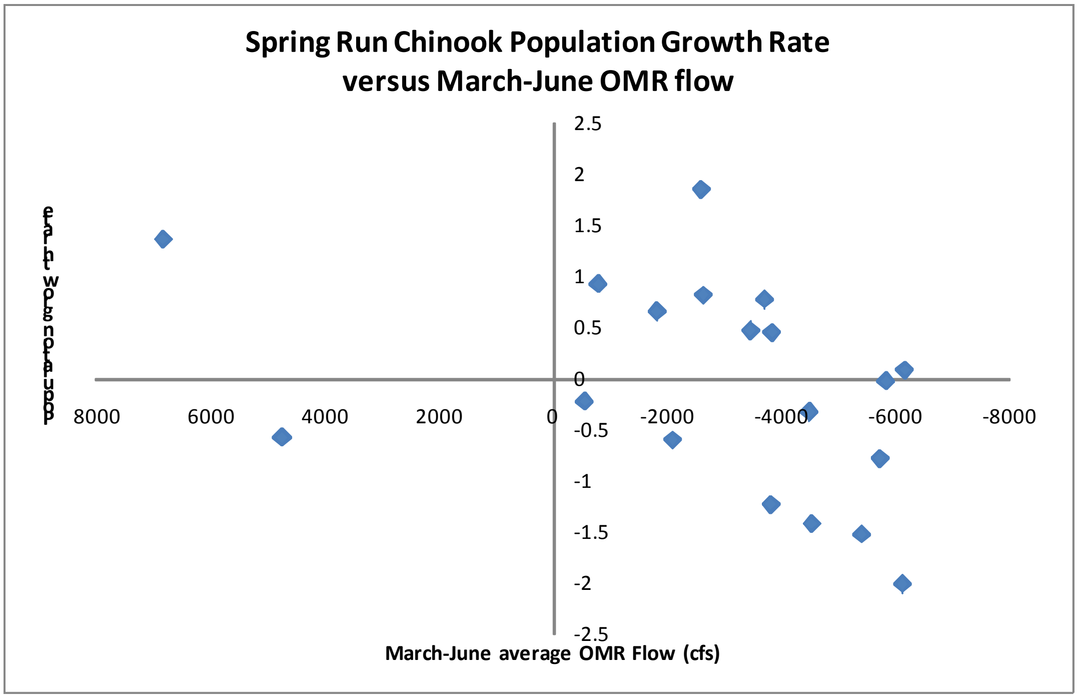

Figure 10b

IV. The Pacific Decadal Oscillation's Effect on Winter-Run Population Growth Rate

41. In my review of the BiOp, I found that while NMFS discussed the major role that ocean conditions play in determining abundance levels of salmonids, the BiOp never quantified that effect so that it could be compared with other stressors, such as the effects caused by water exports. *See* BiOp at 149-153. Scientists have recognized for decades that patterns of change in ocean conditions—and particularly the oceanographic variable known as the Pacific Decadal Oscillation ("PDO") –correspond to major shifts in the productivity of multiple marine fish species on the west coast, including salmon species. *See* Hare & Mantua (1997). Moreover, scientists, including scientists from NMFS, have been performing quantitative analyses of the effects of ocean conditions on salmon for decades. *See* Kope & Botsford, *Determination of Factors Affecting Recruitment of Chinook Salmon* Oncorhynchus tshawytscha *in Central*

[5] For more details on the analysis please see Appendix. In addition, I performed a separate Ricker analysis for winter-run and spring-run chinook using the production rate in the place of the population growth rate. Once again, the results showed no correlation between OMR flow and production rate. Please see the Appendix for the full analysis.

California, Fishery Bulletin, U.S. 88:257-269 (1990) (finding via a quantitative life-cycle analysis a negative effect of the El Niño-Southern Oscillation on California salmon populations).

42. I performed an analysis in which I compared the winter-run chinook population growth rate, calculated from the data in Table 4-2 of the BiOp, with a readily available standard PDO index. *See* PDO Index (*available at* http://jisao.washington.edu/pdo/PDO.latest); *see also*, Decl. of Dr. Daniel E. Schindler in Supp. of Pls. Mot. for Summ. J. ¶ 11-21). I found a statistically significant correlation between winter-run chinook population growth rate and the winter season PDO for the year of return (p-value = 0.00117). The graphical depiction of this relationship in Figure 10c shows a visually identifiable correlation between the two data sets. The red bars represent PDO levels, whereas the black line represents winter-run population growth rate.

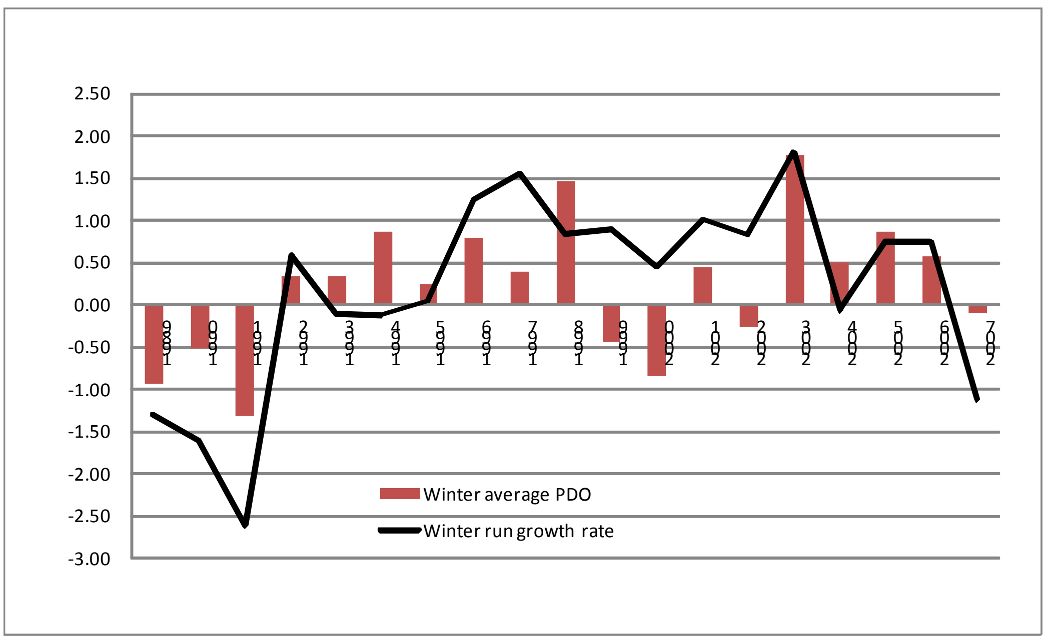

Figure 10c

43. Next, I added the winter PDO data as an additional covariate to the population growth rate analysis that I discussed above. I fitted the Ricker population growth rate model to the data set below, Figure 11b, which includes data on stock density, winter PDO, and December-March OMR flows.

Year of recruitment	Returning escapement	escapement 3 yrs earlier	winter PDO same year as returns	Dec-Mar OMR year after spawn	ln(R/S) population growth rate
1987	2,186				
1988	2,885				
1989	696	2,596	-0.933	-4054.180	-1.316
1990	433	2,186	-0.523	-7319.828	-1.619
1991	211	2,885	-1.317	-6647.835	-2.615
1992	1,240	696	0.343	-8313.000	0.578
1993	387	433	0.333	-4775.041	-0.112
1994	186	211	0.867	-5037.402	-0.126
1995	1,297	1,240	0.240	-5279.793	0.045
1996	1,337	387	0.783	-4656.198	1.240
1997	880	186	0.387	-3031.545	1.554
1998	3,002	1,297	1.467	-1181.664	0.839
1999	3,288	17,205	-0.437	10188.661	-1.655
2000	1,352	2,488	-0.847	2046.463	-0.610
2001	8,224	3,002	0.447	-740.240	1.008
2002	7,441	3,288	-0.267	-5178.418	0.817
2003	8,218	1,352	1.783	-5558.678	1.805
2004	7,701	8,224	0.507	-7615.347	-0.066
2005	15,730	7,441	0.870	-8161.140	0.749
2006	17,205	8,218	0.580	-8004.516	0.739
2007	2,488	7,701	-0.103	-5858.413	-1.130
2008	2,850	15,730	-0.827	-2975.736	-1.708

Figure 11b

44. The results of the initial analysis showed that the PDO variable was a highly significant predictor of variation in the population growth rate (P-value = 0.0001). However, in contrast to the analyses above in Figures 9b and 10b, OMR flow had some statistical significance for the winter-run population growth rate (P-value = 0.028). The apparent cause for this inconsistency with the analyses above, which compared OMR flow solely with the population growth rate, was the highly positive flow levels listed in the table above at 1999 and 2000. These OMR values are listed for 1999 and 2000, but they represent the OMR flow levels for 1997 and 1998, the years that the returning winter-run groups for 1999 and 2000 entered the ocean. The anomalously positive OMR flow for 1997 was the result of the strong El Niño effect that year, which produced highly elevated rainfall and river flows which continued to effect flow rates in

1998.

45. In order to test whether this apparent relationship between OMR flows and winter-run population growth rate was being driven by the two positive OMR outlier points from the El Niño years or represented a real trend in the data, I hypothesized two Ricker models. In the first model, I hypothesized that population growth rate is improved at OMR flow levels above positive 2000 cfs, but that negative OMR flows have no relationship to the population growth rate, which is what the previous analyses demonstrated. In the second model, I hypothesized that population growth rate is improved at OMR flow levels above positive 2000 cfs, but that there is a linear relationship between negative OMR flows and the population growth rate. I then compared the models by calculating the Akaike scores, which compare models according to the weight of the evidence. The result showed that, in accordance with the analyses above showing no statistically signficant relationship between negative OMR flows and abundance, the Akaike weight of the evidence was 71% in favor of the first model. Thus, it is likely that the two highly positive OMR flows from the El Niño years skewed the analysis and created a false relationship between OMR and salmon population growth rate.[6]

46. Regardless, it is apparent that the PDO variable itself is strongly correlated with the winter-run population growth rate (P-value = 0.0001). Figure 11c depicts this relationship graphically and shows the strong correlation between the two factors.

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[6] For the full analysis, please see Appendix.

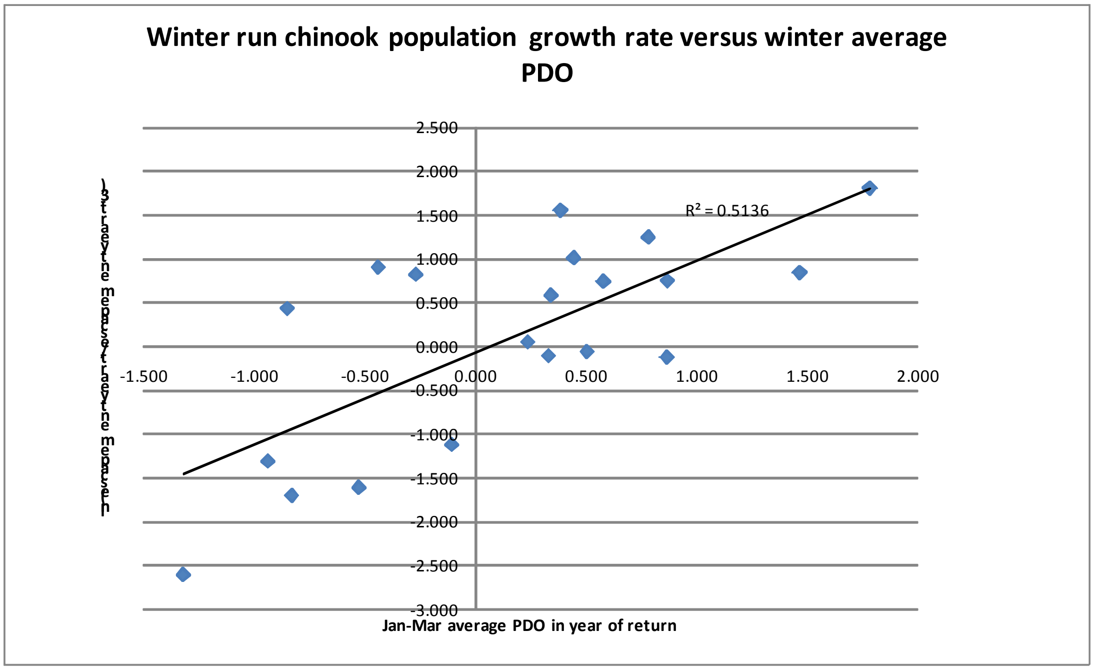

Figure 11c

47. For a final analysis, I calculated the production rate[7] for both winter run and spring run chinook. The production rate estimates for both winter and spring run Chinook were used in place of the population growth rate estimates in the correlation analysis with PDO data. The results were similar to the analysis above in that none of the lagged PDO estimates are significantly correlated to spring run production rates. However, both current winter and spring PDO estimates were statistically significantly correlated to winter run production rates (P-values of 0.0012 and 0.002, respectively). The winter and spring PDO estimates are significantly correlated so I combined them to form average semi-annual PDO estimates. Figures 15 and 16 show comparisons of the winter-spring average PDO and winter run production rate estimates.

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[7] Calculated by taking the logarithm of the production estimate divided by the escapement three years prior.

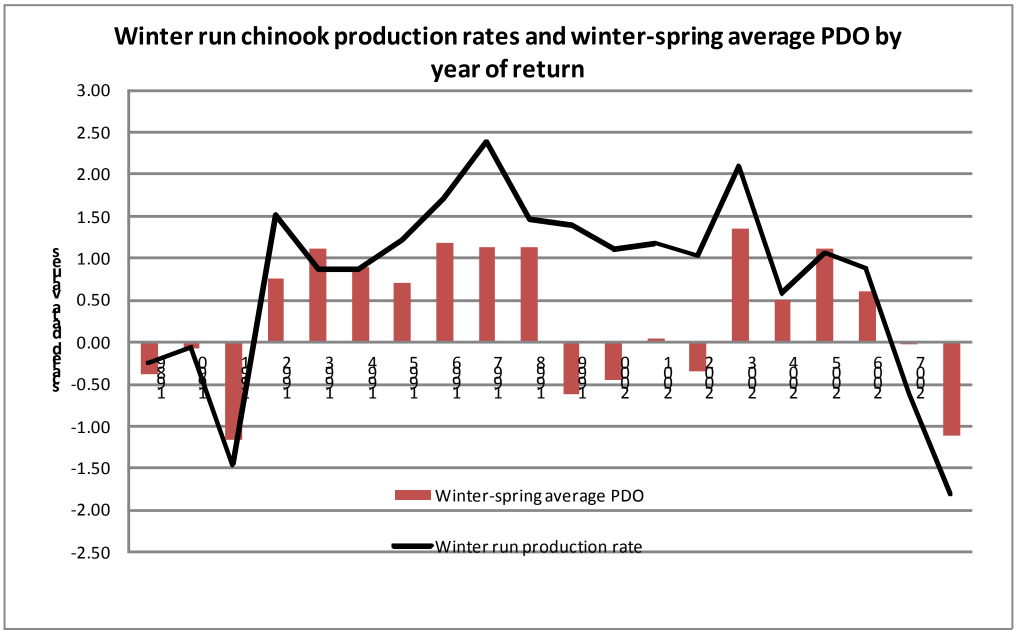

Figure 15

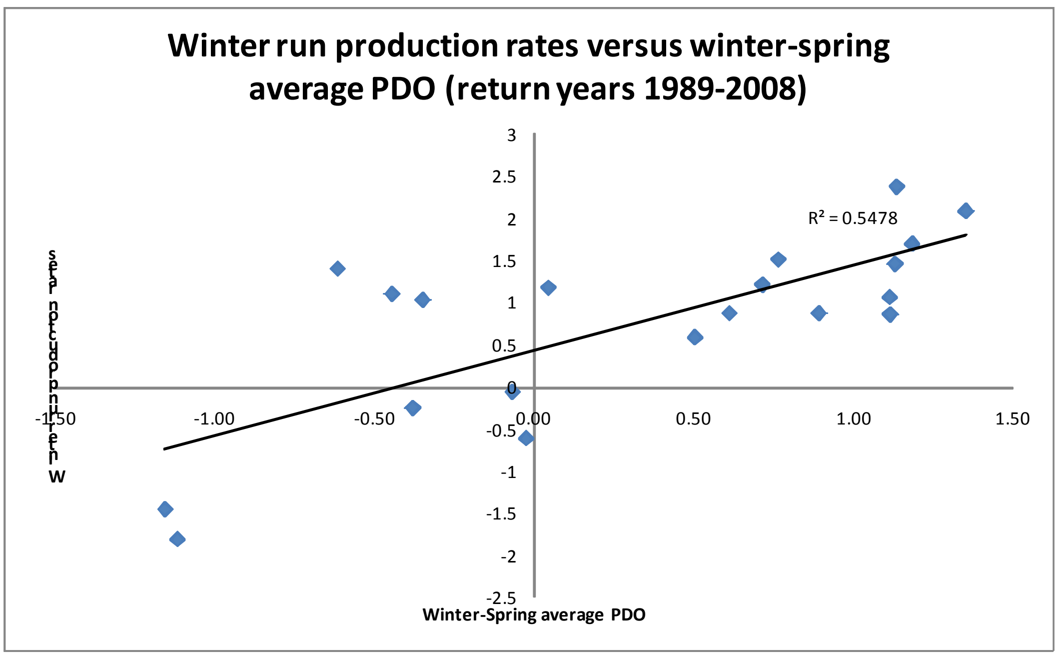

Figure 16

48. These analyses demonstrate two points. First, that there is a strong correlation between winter PDO conditions and the winter-run chinook population growth rate and the production rate, which is consistent with the scientific literature finding a link between the PDO

and salmon populations up and down the Pacific coast. This correlation can be quantitatively analyzed using the data in the BiOp along with data from readily available public sources.

49. Second, and more broadly, my analysis of the PDO demonstrates that use of a population growth rate approach will generally show a strong quantitative correlation between two factors when that relationship actually exists in nature. Here, as noted, there is scientific literature discussing the relationship between PDO and salmon abundance, and NMFS itself uses similar data to predict salmon abundance in other fisheries. *See* Schindler Decl. at ¶¶ 11-21. Correspondingly, the population growth rate showed a highly significant correlation with changes in the PDO. However, as my analyses in Section II above show, there is not a statistically significant relationship between OMR flows and the population growth rate for winter-run and spring-run chinook. A statistical analysis using the population growth rate does not, of course, rule out the possibility that such a relationship exists, but it is a standard first step in determining whether one is likely to find such a relationship, and whether resources devoted to altering a factor in that relationship will actually lead to an improvement in the population growth rate of the species. *See* Independent Peer Review at AR 89612 ("[The spawner-to-recruit ratio, a measure of population growth rate,] is the most common measure of population productivity and is the basis of many population viability analyses that are used to assess the risk of extinction.").

50. This type of quantitative analysis would have shown that ocean conditions have a significant effect on the winter-run population growth rate. The population growth rate analyses described in Section II of this declaration would have shown that OMR flows do not have a statistically significant effect on either winter-run or spring-run population growth rates. Performing these quantitative analyses on the data in the BiOp would have been proper, and would be consistent with the standard practice in the field of fisheries statistics. It is unclear why NMFS did not perform these analyses, especially given that they took the first step of calculating the cohort replacement rate, a measure of population growth rate, for winter-run and spring-run chinook.

53. I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct and that this declaration was executed on August 6, 2010, at Taipei, Taiwan.

Richard B. Deriso

DR. RICHARD B. DERISO

Appendix

Appendix

Life-cycle application to winter run Chinook salmon

A Ricker stock-recruitment model was applied to winter run escapement estimates listed in table 4-2 of the salmon BiOp. The Ricker model was fitted by approximating stock size by the escapement estimate for a given brood year then approximating the next generation stock size by the escapement that occurred three years later. The three-year time lag was chosen because the BiOp states (at table 4-2) that the majority of escapement is composed of three year-olds. More precise analyses would require a run reconstruction of the age composition of the winter run Chinook population but none was presented in the salmon BiOp.

Results from fitting the Ricker model are given in the regression table below. For this analysis data for brood years 1986-2005 were fitted with the Ricker model which included December-March average OMR flow as a covariate variable. Results indicate that the OMR flow variable was not statistically the 5% level of significant (P-value = 0.501). The density-dependent stock term was also not significant (P-value = 0.16). Figure 7 shows results graphically. In Figure 7, population growth rate (that is logarithm of the recruitment to stock size) is graphed versus December-March average OMR flow. As seen in the figure, there is no obvious relationship between population growth rate and OMR flow.

Regression Statistics	
Multiple R	0.402
R Square	0.162
Adjusted R Square	0.063
Standard Error	1.159
Observations	20.000

ANOVA

	df	*SS*	*MS*	*F*
Regression	2.000	4.413	2.206	1.642
Residual	17.000	22.840	1.344	
Total	19.000	27.253		

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0.629	0.404	1.556	0.138
stock	-0.00010	0.00007	-1.482	0.157
OMR	0.00004	0.00006	0.688	0.501

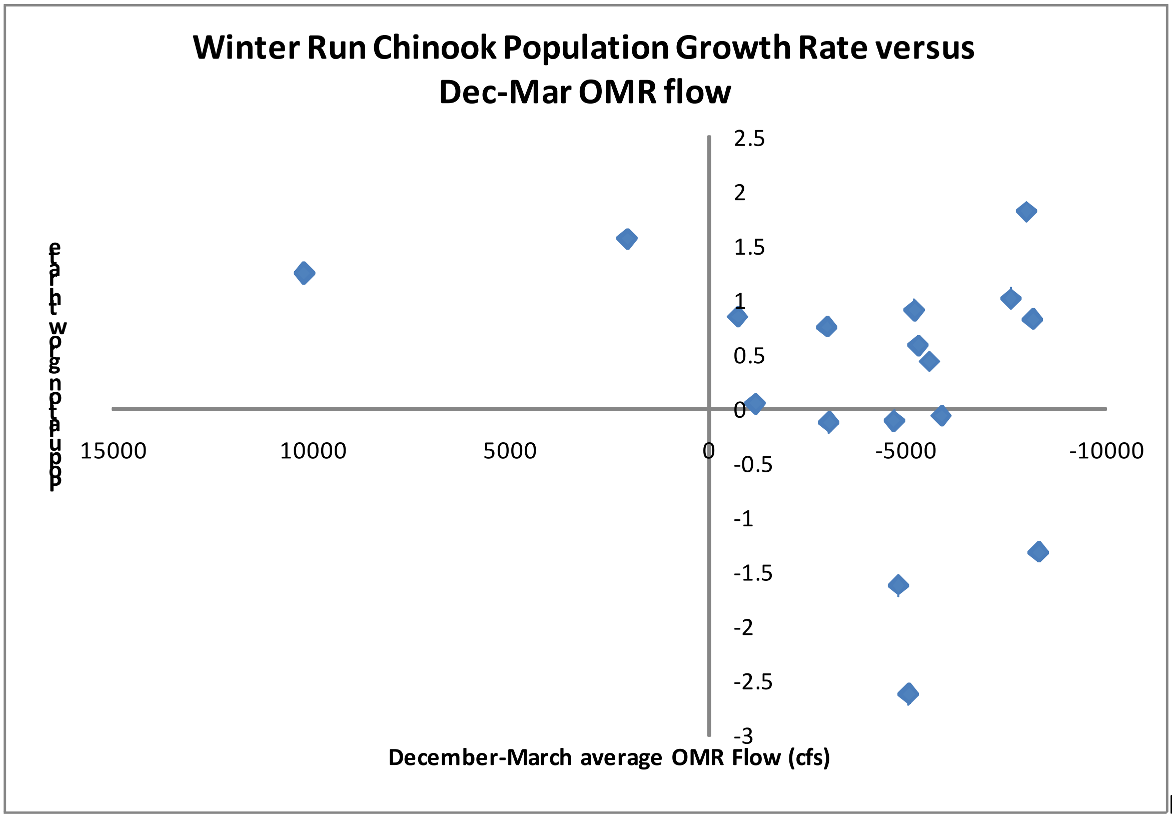
Winter Run Chinook Population Growth Rate versus
Dec-Mar OMR flow
population growth rate
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
15000
10000
5000
0
-5000
-10000
December-March average OMR Flow (cfs)

Figure 7

Life-cycle application to spring run Chinook salmon

A Ricker stock-recruitment model was applied to winter run escapement estimates listed in table 4-5 of the salmon BiOp. The Ricker model was fitted by approximating stock size by the escapement estimate for a given brood year then approximating the next generation stock size by the escapement that occurred three years later. The three-year time lag was chosen because salmon BiOp states that the majority of the escapement consists of three year olds (page97). More precise analyses would require a run reconstruction of the age composition of the winter run Chinook population but none was presented in the salmon BiOp.

Results from fitting the Ricker model are given in the regression table below. For this analysis data for brood years 1986-2004 were fitted with the Ricker model which included March-June average OMR flow as a covariate variable. Results indicate that the OMR flow variable was not statistically the 5% level of significant (P-value = 0.26). The density-dependent stock term was not statistically significant either (P-value = 0.06). In Figure 8, population growth rate (that is logarithm of the escapement to escapement that occurred three years earlier) is graphed versus March-June average OMR flow. As seen in the figure, there is no obvious relationship between population growth rate and OMR flow.

Regression Statistics	
Multiple R	0.575
R Square	0.331
Adjusted R Square	0.247
Standard Error	0.902
Observations	19.000

ANOVA

	df	*SS*	*MS*	*F*
Regression	2.000	6.448	3.224	3.960
Residual	16.000	13.028	0.814	
Total	18.000	19.476		

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0.700	0.345	2.028	0.060
stock	-0.00006	0.00003	-1.987	0.064
OMR	0.00008	0.00007	1.177	0.256

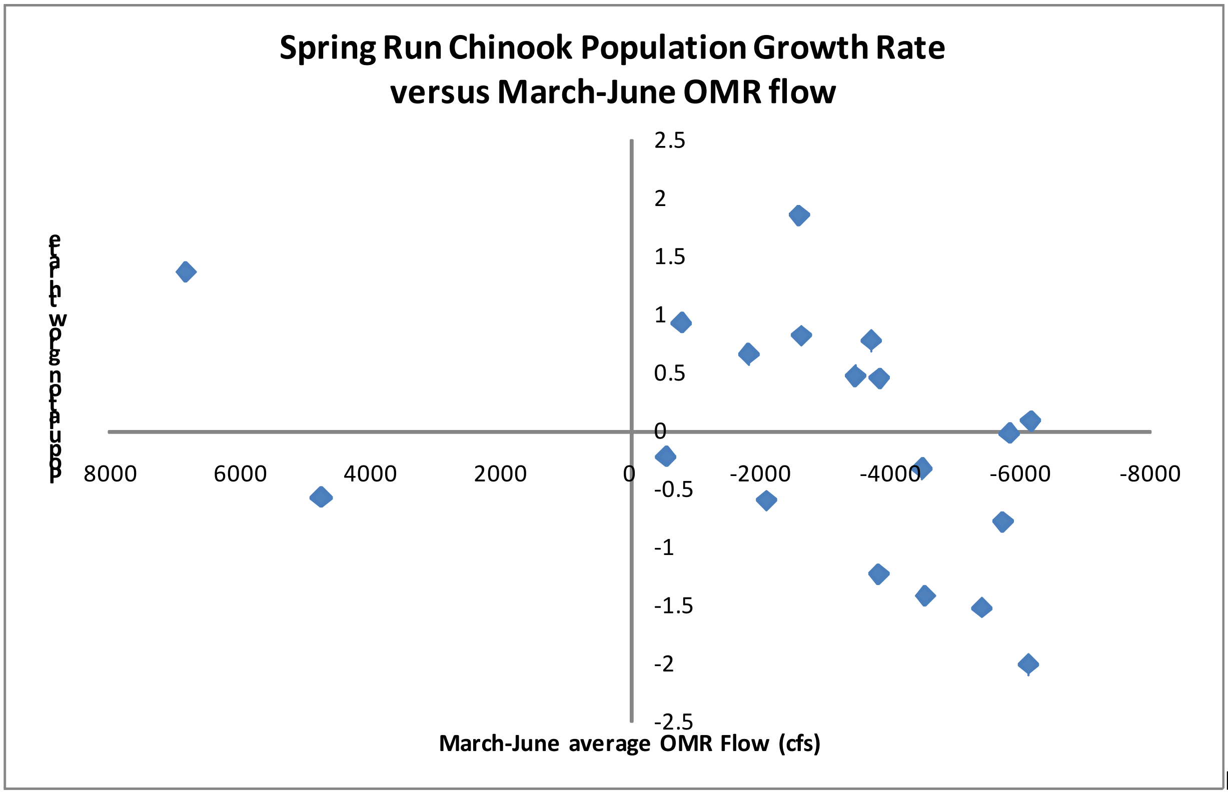
Spring Run Chinook Population Growth Rate
versus March-June OMR flow
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
8000
6000
4000
2000
0
-2000
-4000
-6000
-8000
March-June average OMR Flow (cfs)

Figure 8

Production Life-cycle application to winter run Chinook salmon

An additional sensitivity analysis was made of the life-cycle model application described earlier (Salmon declaration figures (4).docx). In this application recruitment was estimated to be the production estimates made by US Fish & Wildlife in their excel spreadsheet “Chinookprod.xls” located on their website http://www.fws.gov/stockton/afrp/ A Ricker stock-recruitment model was applied to winter run escapement estimates listed in table 4-2 of the salmon BiOp and the production estimates . The Ricker model was fitted by approximating stock size by the escapement estimate for a given brood year then approximating the next generation recruitment by the production estimates that occurred three years later. The three-year time lag was chosen because the BiOp states (at table 4-2) that the majority of escapement is composed of three year-olds. More precise analyses would require a run reconstruction of the age composition of the winter run Chinook population but none was presented in the salmon BiOp.

Results from fitting the Ricker model are given in the regression table below. For this analysis data for brood years 1986-2005 were fitted with the Ricker model which included December-March average OMR flow as a covariate variable. Results indicate that the OMR flow variable was not statistically significant at the 5% level of significance (P-value = 0.804). The density-dependent stock term was significant (P-value = 0.005). Figure 7* shows results graphically. In Figure 7*, population production rate (that is logarithm of the production to stock size) adjusted for density-dependence is graphed versus December-March average OMR flow. As seen in the figure, there is no obvious relationship between population production rate and OMR flow.

Regression Statistics	
Multiple R	0.62876
R Square	0.39534
Adjusted R Square	0.32420
Standard Error	0.89688
Observations	20

ANOVA

	df	*SS*	*MS*	*F*
Regression	2	8.94073	4.47037	5.55748
Residual	17	13.67459	0.80439	
Total	19	22.61532		

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	1.38873	0.31256	4.44308	0.00036
Spawner	-0.00017	0.00005	-3.18523	0.00542
Dec-Mar OMR	0.00001	0.00005	0.25253	0.80366

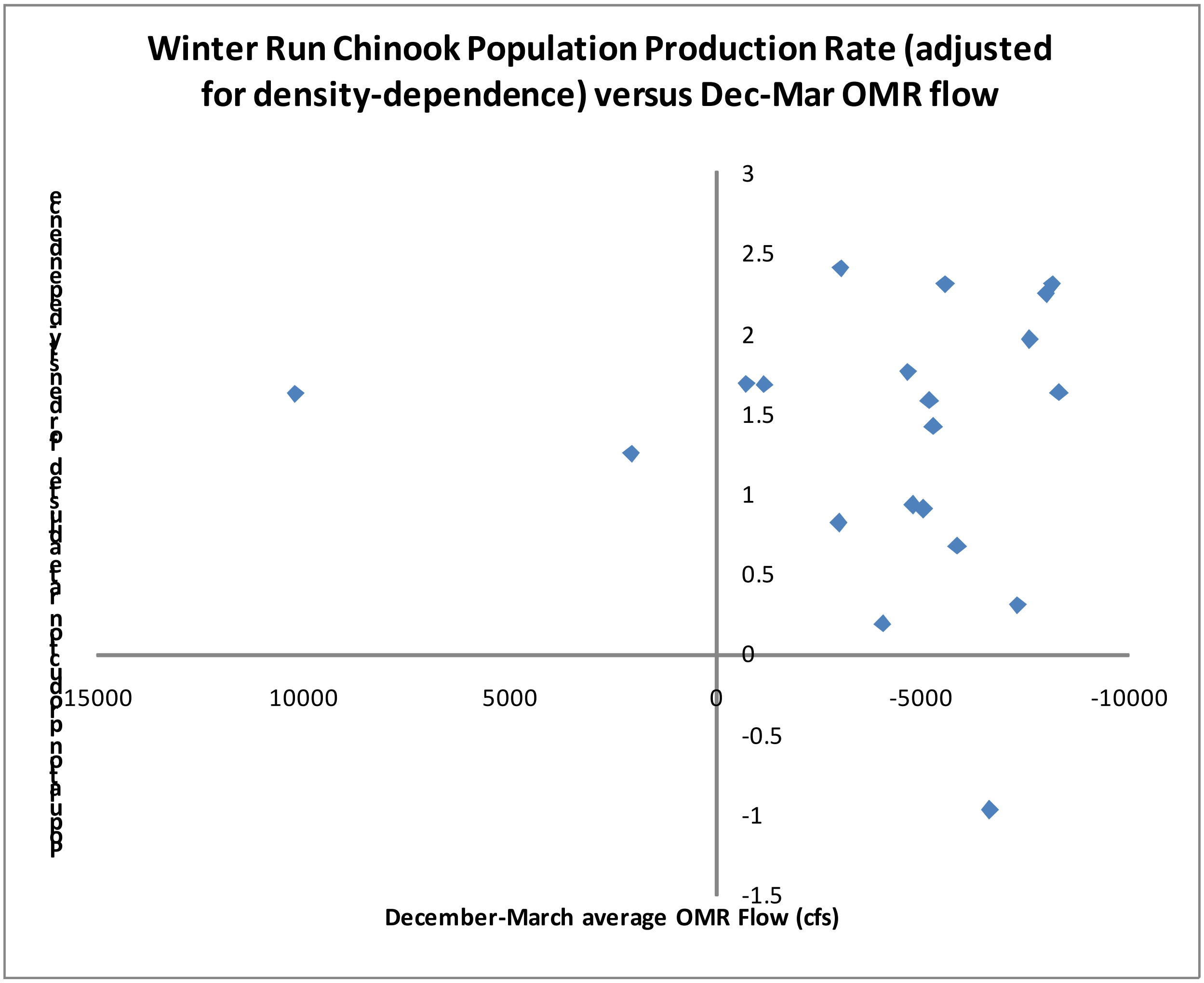
Winter Run Chinook Population Production Rate (adjusted for density-dependence) versus Dec-Mar OMR flow
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
15000
10000
5000
0
-5000
-10000
December-March average OMR Flow (cfs)

Figure 7*

Production Life-cycle application to spring run Chinook salmon

An analysis similar to the winter run analysis reported above was made to production and escapement estimates for the spring run.

Results from fitting the Ricker model are given in the regression table below. For this analysis data for brood years 1986-2004 were fitted with the Ricker model which included March-June average OMR flow as a covariate variable. Results indicate that the OMR flow variable was not statistically the 5% level of significant (P-value = 0.32). The density-dependent stock term was statistically significant (P-value = 0.03). In Figure 8*, population production rate (that is logarithm of the recruitment production to escapement that occurred three years earlier) adjusted for density-dependence is graphed versus March-June average OMR flow. As seen in the figure, there is no obvious relationship between population production rate and OMR flow.

Regression Statistics	
Multiple R	0.6034
R Square	0.3641
Adjusted R Square	0.2846
Standard Error	0.8322
Observations	19

ANOVA

	Df	*SS*	*MS*	*F*
Regression	2	6.3434	3.1717	4.5799
Residual	16	11.0805	0.6925	
Total	18	17.4239		

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	1.525751	0.318235	4.794	0.000
Spawners	-0.000069	0.000030	-2.317	0.034
OMR	0.000061	0.000060	1.019	0.323

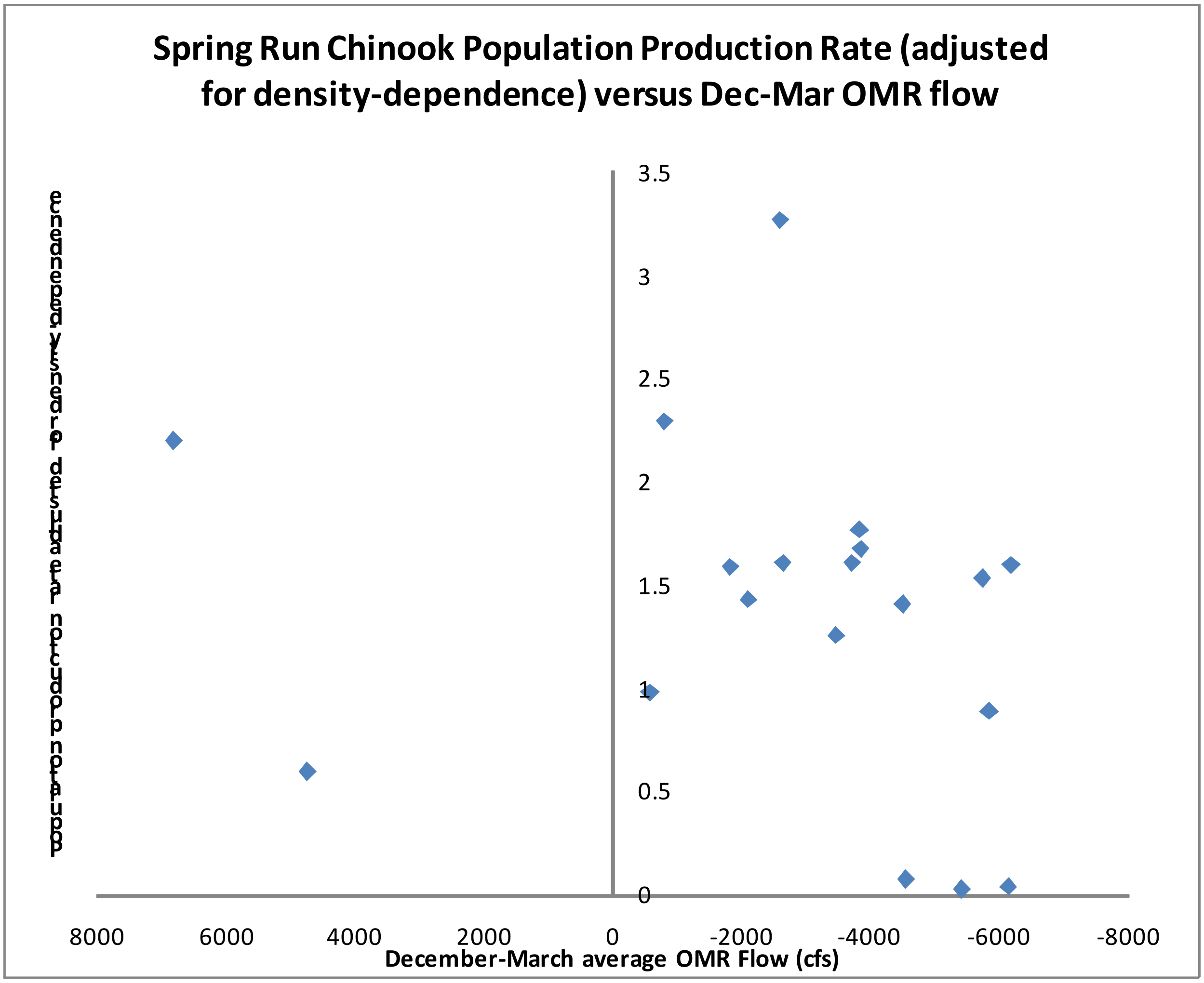
Spring Run Chinook Population Production Rate (adjusted for density-dependence) versus Dec-Mar OMR flow
3.5
3
2.5
2
1.5
1
0.5
0
8000
6000
4000
2000
0
-2000
-4000
-6000
-8000
December-March average OMR Flow (cfs)

Figure 8*