Attachment 5.F.1 Water and Bioaccumulation Modeling Supplemental Information

This attachment contains the tables associated with the water modeling at DSM2 locations and also provides the details of the refinement/calibration of the selenium bioaccumulation models for the Delta, including tables and figures.

5.F.1 Water Modeling

For DSM2 output locations, the geometric mean selenium concentrations from the inflow locations (Table 5.F-1) were combined with the modeled quarterly average percent inflow for each DSM2 output location to estimate waterborne selenium concentrations at those locations. The models used to estimate these concentrations are presented in Section 5.F.3.1.2.1 of the main Appendix 5.F text. The quarterly and average annual waterborne selenium concentrations for the DSM2 output locations are shown in Attachment Table 5.F-1 (Year 2000), Attachment Table 5.F-2 (Year 2005), and Attachment Table 5.F-3 (Year 2007).

5.F.1.1 Refinement/Calibration of Selenium Bioaccumulation Models for the Delta

Several models were evaluated and refined to estimate selenium uptake in fish from waters in the Delta. Input parameters to the model (K_ds and the number of trophic levels) were varied among the models as refinements were made. Data for largemouth bass (*Micropterus salmoides*) collected in the Delta from areas near DSM2 output locations were used to calculate the geometric mean selenium concentration in whole-body fish (Foe 2010). The ratio of the estimated selenium concentration in fish to measured selenium in whole-body bass was used to evaluate each fish model and to focus refinements of the model. These Delta-wide models are presented in the following subsections (modeling for sturgeon did not require refinement because it relied on recent data provided by Presser and Luoma 2013 or other literature sources and assumptions), as described in the main Appendix 5.F text.

Characteristics of water flow in the Delta affect selenium bioaccumulation and the model refinements, because longer residence time for the water can be expected to increase bioaccumulation by increasing K_d. Foe (2010) reported the water year type for 2000 as "above normal" for both the Sacramento River and San Joaquin River watersheds. It came after "wet" water years and was followed by "dry" water years. Year 2005 was wetter than 2000, was reported as "above normal" for the Sacramento River watershed and wet for the San Joaquin River watershed, and occurred between periods of wet water years. Water Year 2007 was reported as dry (Sacramento River watershed) and "critically dry" (San Joaquin River watershed). It came after wet water years and was followed by critically dry water years.

There was no difference in bass selenium concentrations in the Sacramento River at Rio Vista in comparison to the San Joaquin River at Vernalis in 2000, 2005, and 2007 (Foe 2010). The lack of a difference in bioavailable selenium between the two river systems was unexpected because the San Joaquin River is considered a significant source of selenium to the Delta. Year 2005 selenium concentrations in bass were comparatively lower than those estimated for Year 2000. As expected in a wet water year, the water residence time was shorter, resulting in less selenium recycling, lower K_d values, and lower concentrations of selenium entering the food web. The dry water year (2007) resulted in a longer water residence time, higher K_d values, greater selenium recycling, and higher concentrations of bioavailable selenium entering the food web. These differences among years were considered when refining the selenium bioaccumulation model.

Models estimating whole-body selenium concentrations in fish were refined by modifying dietary composition and input parameters to closely represent measured conditions in the Delta. Each model is described in this section.

Model 1 was a basic representative of uptake by a forage fish, while Model 2 calculated sequential bioaccumulation in a more complex food web that included predatory fish eating forage fish, as shown below:

Model 1: Trophic level 3 (TL-3) fish eating invertebrates

$$C_{fish} = C_{particulate} \bullet TTF_{invertebrate} \bullet TTF_{fish} \quad \text{[Eq. 1]}$$

Model 2: Trophic level 4 (TL-4) fish eating TL-3 fish

$$C_{predator\ fish} = C_{particulate} \bullet TTF_{inverterbrate} \bullet TTF_{forage\ fish} \bullet TTF_{predator\ fish} \quad \text{[Eq. 2]}$$

Where:

C_{fish} = concentration of selenium in fish (µg/g dw)

$C_{particulate}$ = concentration of selenium in particulate material (µg/g dw)

$TTF_{invertebrate}$ = Trophic transfer factor from particulate material to invertebrate

TTF_{fish} = Trophic transfer factor from invertebrate or fish to fish

In both Models 1 and 2, the particulate selenium concentration was estimated using Equation 2 and a default K_d of 1,000 (Presser and Luoma 2010a). The average TTFs for invertebrates (2.8) and fish (1.1) were used in each model. The outputs of estimated selenium concentrations and the ratios of predicted-to-observed bass selenium concentrations for Models 1 and 2 are presented in Attachment Table 5.F-4 and Attachment Figure 5.F-1.

Models 1 and 2 tended to substantially underestimate the whole-body selenium concentrations in fish when compared to bass data reported in Foe (2010). This was partly because Model 1 was estimating selenium concentration in a forage fish (TL-3), whereas bass are a predatory fish with expected higher dietary exposure. Consequently, Model 1 was not further developed as the selenium bioaccumulation model to represent fish in the Delta.

Model 2 is representative of predatory fish, but Model 2 was very similar to Model 1 in distribution of data and in underestimating bass data, even though an additional trophic-level transfer was included in the model. As noted here and described in much greater detail by Presser and Luoma (2010a, 2010b, 2013), the K_ds for uptake from water are far more variable than the TTFs for invertebrates or fish. Models 1 and 2 also apparently reflect the tendency of selenium (as an essential nutrient) to be more bioaccumulative when waterborne concentrations are low (as described by Stewart et al. 2010), which they were for the DSM2-modeled concentrations (i.e., 0.09 to 0.85 µg/L). Available K_d values from various sampling efforts in the Delta provided by Presser and Luoma (2010b) were reviewed for potential applicability in the modeling effort. Those values varied on the basis of locations within the Delta and Suisun Bay and also by water year and flow characteristics (often greater than 5,000 and sometimes exceeding 10,000). However, efforts to incorporate various selected K_ds (e.g., 2,000 or 3,000) into the model uniformly for different DSM2 locations failed to produce ratios of modeled-to-measured fish selenium concentrations that approximated 1 (they either over- or underestimated fish selenium because of variability in site conditions).

The available bass data and the assumed TTFs for fish (1.1) and invertebrates (2.8) were used to back-calculate a location and sample-specific K_d. It is recognized that some of the variability in bioaccumulation may be associated with the TTFs, but there were no reasonable assumptions for selection of alternative values to plug into the model.

When TTFs were held constant, back-calculation of K_d values revealed a concentration-related influence on the values. For waterborne selenium concentrations in the range of 0.09 to 0.13 µg/L (N = 50), the median K_d was 5,575; when waterborne selenium concentrations were in the range of 0.14 to 0.40 µg/L (N = 19), the median K_d was 2,431; for waterborne selenium concentrations in the range of 0.41 to 0.85 µg/L (N = 19), the median K_d was 748. These observations are consistent with an inverse relationship between waterborne selenium concentrations and bioaccumulation in aquatic organisms.

Attachment Figure 5.F-2 shows the log-log regression relation of K_d to waterborne selenium concentration when all years are included and the TTFs are held constant, while Attachment Figure 5.F-3 shows the relationship for normal/wet years (2000 and 2005) and Attachment Figure 5.F-4 shows the regression for dry years (2007), when the K_ds were generally higher.

Model 3 is based on Model 2 (with TTFs as described above) but includes the K_d estimated from the log-log regression relation for all years (Attachment Figure 5.F-2). This produced a median ratio of predicted-to-observed whole-body selenium in bass that was slightly less than 1 (Attachment Figure 5.F-1); details are provided in Attachment Table 5.F-5. Because of the noticeable differences between 2007 (the dry year) in comparison to the other two years, the next step in modeling was to evaluate 2007 separately from 2000 and 2005.

Model 4 was developed using the log-log relationship between K_d and water selenium concentrations for 2000/2005 (Attachment Figure 5.F-3), and Model 5 was developed using log-log relationship between K_d and water selenium concentrations for 2007 (Attachment Figure 5.F-4) (Attachment Table 5.F-6). These two models produced ratios of predicted-to-observed whole-body selenium in bass approximating 1, as shown in Attachment Figure 5.F-1.

As expected in a large, complex, and diverse ecological habitat such as the Delta, variations in the data distribution and in the outputs of the models are not surprising. However, it should be noted that the estimated K_ds for Models 3 (618-6,091; Attachment Table 5.F-5), 4 (598-5,145; Attachment Table 5.F-6), and 5 (1,206-8,064; Attachment Table 5.F-6) are consistent with those summarized by Presser and Luoma (2010b) for the Delta.

Attachment Figures 5.F-5 and 5.F-6 illustrate the distribution of data for selenium concentrations in largemouth bass (Foe 2010) relative to the measured or DSM2-modeled waterborne selenium concentrations (Attachment Tables 5.F-1 through 5.F-3) and Models 3, 4, and 5 to complement the boxplots shown in Attachment Figure 5.F-1. There is notably more variability in selenium concentrations in bass between 0.09 and 0.13 µg/L than at higher waterborne selenium concentrations (as shown in both Attachment Figures 5.F-5 and 5.F-6); most of the higher values are from 2007 and most of the lower ones are from 2005.

Attachment Figure 5.F-5 shows the available data for 2000, 2005, and 2007 plotted with the Model 3 prediction of selenium concentrations. As noted above in text and in Attachment Figure 5.F-1, the model slightly under-predicts the median concentrations in fish on the basis of waterborne selenium concentrations. However, overall, the model is within 1 µg/g for all values below the prediction, and within about 1.2 µg/g for the values that are above the prediction (Attachment Figure 5.F-5).

Because of the notable differences between data for 2007 in comparison to combined 2000 and 2005, we developed Model 4 for 2000/2005 and Model 5 for 2007; Attachment Figure 5.F-6 shows those model predictions in comparison to the data. These two models improved the predictions; although the figure shows more differences between data and the models at the lower waterborne concentrations (i.e., < 0.30 µg/L) than at higher ones, the divergence is generally < 0.5 µg/g at the higher waterborne concentrations. The outliers for Model 4 are mostly above the 90th percentile (i.e., over-predicting concentrations in fish), rather than below, though those below (i.e., under-predicting concentrations in fish) influence the mean to get a slight under-prediction as shown in Attachment Figure 5.F-1. For Model 5, the predictions are "tighter" with just a few outliers above or below the 90th percentile.

Overall, evaluation of water-year effects on selenium concentration in bass concluded that Model 4 is relatively predictive of selenium concentration in whole-body bass during normal to wet water years, Model 5 is considered predictive for dry water years (e.g., 2007), and Model 3 incorporates the varying bioaccumulation when all years are considered (i.e., 2000, 2005, and 2007). Although Model 3 tends to slightly overestimate selenium bioaccumulation (Attachment Table 5.F-5 and Attachment Figure 5.F-1), it was used for estimating selenium concentrations in whole-body fish to compare the PA to the NAA in this analysis for "wet, above normal, and below normal" years, and Model 5 was used for "dry and critical" years.

5.F.1.2 References

Foe, C. 2010. Selenium Concentrations in Largemouth Bass in the Sacramento–San Joaquin Delta. Central Valley Regional Water Quality Control Board, Sacramento, CA. June.

Presser, T.S., and S.N. Luoma. 2010a. A methodology for ecosystem-scale modeling of selenium. *Integrated Environmental Assessment and Management* 6:685-710.

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Presser, T.S., and S.N. Luoma. 2013. Ecosystem-scale Selenium Model for the San Francisco Bay-Delta Regional Ecosystem Restoration Implementation Plan. *San Francisco Estuary and Watershed Science* 11:1-39.

Stewart, R., M. Grosell, D. Buchwalter, N. Fisher, S. Luoma, T. Mathews, P. Orr, and W.-X. Wang. 2010. Bioaccumulation and Trophic Transfer of Selenium. *Ecological Assessment of Selenium in the Aquatic Environment*. 93-139. Eds. P.M. Chapman, W.J. Adams, M.L. Brooks, C.G. Delos, S.N. Luoma, W.A. Maher, H.M. Ohlendorf, T.S. Presser, and D.P. Shaw. Boca Raton: CRC Press.

Attachment Table 5.F-1. Calculation of Quarterly Average Selenium Concentrations for DSM2 Output Locations Based on Percentage of Flow at Each Location from Different Sources: Year 2000

		First Quarter Inflow Percentage						Second Quarter Inflow Percentage						Third Quarter Inflow Percentage						Fourth Quarter Inflow Percentage						Estimated Waterborne Selenium Concentrations (µg/L)				
	Inflow Source →	**Delta Ag.**	**East Delta Tributaries**	**Sac. R.**	**San Joaq. R.**	**Martinez/ Suisun Bay**	**Yolo Bypass**	**Delta Ag.**	**East Delta Tributaries**	**Sac. R.**	**San Joaq. R.**	**Martinez/ Suisun Bay**	**Yolo Bypass**	**Delta Ag.**	**East Delta Tributaries**	**Sac. R.**	**San Joaq. R.**	**Martinez/ Suisun Bay**	**Yolo Bypass**	**Delta Ag.**	**East Delta Tributaries**	**Sac. R.**	**San Joaq. R.**	**Martinez/ Suisun Bay**	**Yolo Bypass**					
	Inflow Location →	***Mildred Island, Center***	***Mokelumne Calaveras Cosumnes Rivers***	***Freeport***	***Vernalis***	***San Joaq. R. near Mallard Island***	***Sac. R. below Knights Landing***	***Mildred Island, Center***	***Mokelumne Calaveras Cosumnes Rivers***	***Freeport***	***Vernalis***	***San Joaq. R. near Mallard Island***	***Sac. R. below Knights Landing***	***Mildred Island, Center***	***Mokelumne Calaveras Cosumnes Rivers***	***Freeport***	***Vernalis***	***San Joaq. R. near Mallard Island***	***Sac. R. below Knights Landing***	***Mildred Island, Center***	***Mokelumne Calaveras Cosumnes Rivers***	***Freeport***	***Vernalis***	***San Joaq. R. near Mallard Island***	***Sac. R. below Knights Landing***					
DSM2 Output	**Selenium (µg/L) →**	0.11	0.10	0.09	0.83	0.10	0.23	0.11	0.10	0.09	0.83	0.10	0.23	0.11	0.10	0.09	0.83	0.10	0.23	0.11	0.10	0.09	0.83	0.10	0.23	**1st Quarter**	**2nd Quarter**	**3rd Quarter**	**4th Quarter**	**Annual**
Water Location	**Location ID**																													
Big Break	BIGBRK_MID	2.94	6.88	53.15	6.59	0.18	5.70	2.95	6.37	73.59	13.55	0.27	3.12	3.13	0.45	85.63	0.44	4.15	6.12	2.13	0.20	84.85	0.02	8.76	3.96	0.13	0.20	0.10	0.10	0.13
Cache Slough	CACHS_LEN	1.46	0	53.38	0	0	31.91	1.24	1.5E-05	85.07	2.5E-05	0	13.25	1.66	4.7E-07	85.95	4.3E-07	5.9E-07	12.23	1.32	2.8E-06	89.83	1.1E-07	2.3E-05	8.67	0.12	0.11	0.11	0.10	0.11
Cache Slough Ryer	CACHSR_MID	2.88	0	54.86	0	0	20.48	3.36	9.8E-07	79.75	1.9E-06	0	16.25	1.90	9.3E-08	84.53	1.8E-07	9.2E-12	13.38	1.81	1.0E-07	89.45	6.2E-10	3.0E-06	8.54	0.10	0.11	0.11	0.10	0.11
Cosumnes R.	COSR_LEN	8.1E-06	98.82	0	0	0	0	0	100.00	0	0	0	0	0	100.00	0	0	0	0	0	100.00	0	0	0	0	0.10	0.10	0.10	0.10	0.10
Franks Tract	FRANKST_MID	5.06	11.56	43.94	15.79	0.02	0.32	4.17	9.42	61.16	23.89	0.01	1.22	4.04	0.57	90.34	0.41	0.80	3.78	2.76	0.62	91.38	0.12	2.42	2.64	0.19	0.27	0.10	0.10	0.16
Little Holland Tract	LHOLND_L0	72.35	0	5.06	0	0	6.50	23.38	8.2E-07	63.10	1.6E-06	0	13.03	18.48	2.2E-07	68.67	4.2E-07	7.2E-13	12.68	19.63	2.6E-09	72.79	0	0	7.42	0.10	0.11	0.11	0.10	0.11
Middle R Bullfrog	MIDRBULFRG_LEN	10.54	13.07	18.37	32.20	1.9E-03	3.2E-03	5.49	9.19	14.96	70.17	4.2E-04	0.10	7.81	6.43	69.63	14.94	0.12	1.02	4.86	6.31	59.79	27.84	1	0.68	0.31	0.61	0.20	0.30	0.36
Mildred Island	MILDDRISL_MID	7.47	14.31	22.79	30.23	2.4E-03	1.8E-03	4.77	10.05	18.48	66.48	6.7E-04	0.13	6.57	4.57	83.28	4.14	0.15	1.25	4.50	6.63	71.28	16.13	0.61	0.82	0.29	0.58	0.12	0.21	0.30
Mok. R. below Cosum.	MOKBCOS_LEN	2.07	96.19	0	0	0	0	1.65	98.35	0	0	0	0	7.23	92.77	4.7E-09	0	0	0	2.47	97.53	0	0	0	0	0.10	0.10	0.10	0.10	0.10
Mok. R. downstream Cosum.	MOKDCOS_MID	2.07	96.43	0	0	0	0	1.68	98.32	0	0	0	0	7.08	92.92	0	0	0	0	2.34	97.66	0	0	0	0	0.10	0.10	0.10	0.10	0.10
Old R near Paradise Cut	OLDRNPARADSEC_MID	6.24	0	0	87.26	0	0	14.40	1.67	5.21	78.66	1.2E-05	0.04	10.56	3.9E-05	1.3E-04	89.44	8.8E-28	3.0E-07	2.50	1.1E-04	3.5E-04	97.50	2.8E-20	1.7E-07	0.73	0.68	0.75	0.81	0.74
Paradise Cut	PARADSECUT_LEN	4.69	0	0	91.37	0	0	2.62	0.06	0.15	97.16	1.5E-07	1.1E-03	3.43	0	0	96.57	0	0	0.96	0	0	99.04	0	0	0.76	0.81	0.81	0.82	0.80
Port of Stockton	PORTOSTOCK_L0	1.67	0	0	18.85	0	0	2.22	0	0	60.73	0	0	3.09	0	0	81.32	0	0	2.70	0	0	89.89	0	0	0.16	0.51	0.68	0.75	0.52
Sac. R. at Isleton	SACRISLTON_L0	0.33	0	95.77	0	0	0	0.31	0.00	99.60	0	0	5.5E-05	0.44	0	99.55	0	0	1.3E-05	0.28	0	99.72	0	0	1.1E-03	0.09	0.09	0.09	0.09	0.09
Sac River RM 44	SACR44_L0	0.14	0	97.93	0	0	0	0.11	0	99.81	0	0	0	0.13	0	99.86	0	0	0	0.05	0	99.94	0	0	0	0.09	0.09	0.09	0.09	0.09
Sandmound Sl.	SANDMND_MID	6.36	10.51	43.82	12.90	0.03	0.57	5.22	8.81	63.78	20.40	0.03	1.63	5.24	0.61	87.78	0.49	1.22	4.59	3.31	0.43	89.58	0.06	3.44	3.11	0.17	0.25	0.10	0.10	0.15
Sherman Island	SHERMNILND_L0	1.64	3.45	52.71	3.93	0.60	12.10	2.48	4.95	76.80	10.96	0.96	3.67	2.60	0.40	81.69	0.46	8.21	6.56	1.77	0.11	77.64	0.01	16.46	3.94	0.11	0.18	0.10	0.10	0.12
SJR Bowman	SJRBOWMN_MID	1.40	0	0	94.03	0	0	1.52	0	0	98.48	0	0	3.00	0	0	97.00	0	0	0.33	0	0	99.67	0	0	0.78	0.82	0.81	0.83	0.81
SJR N Hwy4	SJRNHWY4_MID	3.49	0	0	89.96	0	0	1.87	0	0	98.13	0	0	3.91	0	0	96.09	0	0	0.72	0	0	99.28	0	0	0.75	0.82	0.80	0.82	0.80
SJR Naval st	SJRNAVLST_L0	8.89	12.70	0.00	65.44	0	0	2.69	6.26	0	90.94	0	0	5.98	10.89	0	83.00	0	0	2.02	3.10	0.00	94.84	0	0	0.57	0.76	0.71	0.79	0.71
SJR Potato Slough	SJRPOTSL_MID	3.15	12.62	55.38	12.40	0.01	0.06	3.05	10.32	65.93	19.73	0.01	0.86	2.63	0.35	93.54	0.20	0.45	2.79	2.06	0.80	93.46	0.06	1.47	2.11	0.17	0.24	0.10	0.09	0.15
SJR Turner	SJRTURNR_MID	8.81	9.28	2.55	56.31	5.3E-05	1.0E-05	3.33	5.77	0.41	90.39	6.3E-06	2.4E-03	8.69	13.75	17.87	59.41	0.01	0.16	3.23	4.83	7.34	84.49	0.03	0.05	0.49	0.76	0.53	0.72	0.62
SJR/Pt. Antioch/fish pier	ASRANTFSH_MID	1.92	4.35	55.13	4.50	0.44	10.23	2.45	4.72	77.70	10.28	0.76	3.91	2.64	0.35	83.38	0.38	6.66	6.52	1.82	0.12	80.54	0.01	13.33	4.11	0.12	0.17	0.10	0.10	0.12
Suisun Bay	SUISNB_LEN	0.81	1.22	45.93	1.24	16.49	15.94	0.92	1.66	49.51	3.61	41.10	2.95	0.80	0.23	27.56	0.40	68.55	2.42	0.60	0.03	28.62	0.01	69.16	1.54	0.11	0.13	0.10	0.10	0.11
Sycamore Slough	SYCAMOR_MID	6.50	50.69	15.18	0	0	0	5.89	76.86	16.89	2.8E-07	0	0	5.04	14.29	80.66	1.2E-31	0	0	4.23	31.10	64.66	0	0	0	0.07	0.10	0.09	0.09	0.09
White Slough	WHITESL_L0	22.32	11.88	17.97	25.51	1.7E-08	6.0E-11	16.54	12.10	16.87	54.46	3.7E-09	6.1E-05	9.89	7.76	82.34	3.8E-03	3.0E-05	5.3E-04	11.19	12.92	75.64	0.24	4.2E-04	6.4E-04	0.26	0.50	0.09	0.10	0.24
White Slough DS Disappointment Sl.	WHTSLDISPONT_LEN	14.83	22.63	29.02	22.45	5.4E-08	0	12.45	13.97	21.21	52.32	2.2E-09	2.3E-04	8.74	7.78	83.47	2.4E-03	4.0E-05	5.6E-04	5.28	14.84	79.82	0.05	5.0E-04	7.3E-04	0.25	0.48	0.09	0.09	0.23

Attachment Table 5.F-2. Calculation of Quarterly Average Selenium Concentrations for DSM2 Output Locations Based on Percentage of Flow at Each Location from Different Sources: Year 2005

		First Quarter Inflow Percentage						Second Quarter Inflow Percentage						Third Quarter Inflow Percentage						Fourth Quarter Inflow Percentage						Estimated Waterborne Selenium Concentrations (µg/L)				
	Inflow Source →	Delta Ag.	East Delta Tributaries	Sac. R.	San Joaq. R.	Martinez/ Suisun Bay	Yolo Bypass	Delta Ag.	East Delta Tributaries	Sac. R.	San Joaq. R.	Martinez/ Suisun Bay	Yolo Bypass	Delta Ag.	East Delta Tributaries	Sac. R.	San Joaq. R.	Martinez/ Suisun Bay	Yolo Bypass	Delta Ag.	East Delta Tributaries	Sac. R.	San Joaq. R.	Martinez/ Suisun Bay	Yolo Bypass					
	Inflow Location →	*Mildred Island, Center*	*Mokelumne Calaveras Cosumnes Rivers*	*Freeport*	*Vernalis*	*San Joaq. R. near Mallard Island*	*Sac. R. below Knights Landing*	*Mildred Island, Center*	*Mokelumne Calaveras Cosumnes Rivers*	*Freeport*	*Vernalis*	*San Joaq. R. near Mallard Island*	*Sac. R. below Knights Landing*	*Mildred Island, Center*	*Mokelumne Calaveras Cosumnes Rivers*	*Freeport*	*Vernalis*	*San Joaq. R. near Mallard Island*	*Sac. R. below Knights Landing*	*Mildred Island, Center*	*Mokelumne Calaveras Cosumnes Rivers*	*Freeport*	*Vernalis*	*San Joaq. R. near Mallard Island*	*Sac. R. below Knights Landing*					
DSM2 Output	Selenium (µg/L) →	0.11	0.10	0.09	0.85	0.10	0.23	0.11	0.10	0.09	0.85	0.10	0.23	0.11	0.10	0.09	0.85	0.10	0.23	0.11	0.10	0.09	0.85	0.10	0.23	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual
Water Location	**Location ID**																													
Big Break	BIGBRK_MID	5.87	7.57	83.73	2.41	0.24	0.18	2.90	17.21	52.77	26.69	1.6E-03	0.43	3.31	2.21	88.77	1.70	3.98	0.03	2.39	0.24	90.17	0.01	6.48	0.70	0.11	0.30	0.10	0.09	0.15
Cache Slough	CACHS_LEN	4.89	2.2E-07	93.64	8.E-07	3.8E-07	1.47	1.48	7.1E-07	94.13	8.0E-07	1.1E-08	4.38	1.94	1.7E-05	98.02	1.0E-05	1.6E-06	0.05	2.30	1.2E-05	92.72	4.6E-07	0.00	4.98	0.09	0.10	0.09	0.10	0.09
Cache Slough Ryer	CACHSR_MID	8.13	3.0E-07	91.14	1.2E-06	1.3E-06	0.73	3.74	2.5E-08	91.89	1.0E-07	2.9E-08	4.38	2.15	5.6E-07	97.77	2.6E-07	4.5E-09	0.08	2.66	8.8E-07	96.37	1.9E-08	7.6E-06	0.97	0.09	0.10	0.09	0.09	0.09
Cosumnes R.	COSR_LEN	0	100.00	0	0	0	0	0.00	100.00	0.00	0	0	0	0	100	0	0	0	0	1.2E-04	100.00	0	0	0	0	0.10	0.10	0.10	0.10	0.10
Franks Tract	FRANKST_MID	8.65	11.65	72.50	7.E+00	0.19	0.05	4.63	16.63	26.97	51.74	1.1E-04	0.03	4.27	3.20	89.93	1.81	0.77	0.02	3.17	0.81	94.16	0.06	1.74	0.05	0.15	0.49	0.11	0.09	0.21
Little Holland Tract	LHOLND_L0	97.11	3.2E-09	2.88	9.E-09	3.9E-09	0.01	44.12	6.5E-09	53.25	2E-08	1.2E-08	2.63	18.61	5.6E-07	81.24	0.00	0.00	0.16	46.22	6.1E-08	53.77	2.8E-08	2.6E-09	0.01	0.11	0.10	0.09	0.10	0.10
Middle R Bullfrog	MIDRBULFRG_LEN	13.67	9.76	28.26	48.24	0.08	0.01	5.55	5.64	2.70	86.11	7.1E-05	8.4E-04	7.43	12.50	53.07	26.88	0.12	3.1E-03	5.54	8.75	65.65	19.67	0.39	1.1E-03	0.46	0.75	0.30	0.24	0.44
Mildred Island	MILDDRISL_MID	12.36	11.39	32.28	43.87	8.4E-02	0.01	4.81	6.98	2.78	85.43	3.6E-05	6.7E-04	6.73	12.68	65.46	14.98	0.15	3.9E-03	4.81	7.16	77.85	9.71	0.47	1.8E-03	0.43	0.74	0.21	0.17	0.38
Mok. R. below Cosum.	MOKBCOS_LEN	2.18	97.82	0	0.00	0	0	0.53	99.47	0	0	0	0	3.05	96.95	0	0	0	0	3.00	97.00	0	0	0	0	0.10	0.10	0.10	0.10	0.10
Mok. R. downstream Cosum.	MOKDCOS_MID	2.22	97.78	0	0.00	0	0	0.53	99.47	0	0	0	0	3.05	96.95	0	0	0	0	2.93	97.07	0	0	0	0	0.10	0.10	0.10	0.10	0.10
Old R near Paradise Cut	OLDRNPARADSEC_MID	8.95	4.7E-05	1.5E-03	91.05	1.4E-05	1.4E-06	1.43	1.7E-07	1.6E-05	98.57	1.7E-08	3.5E-10	6.64	0	5.E-09	93.36	0	0	14.49	0.24	3.16	82.09	0.02	8.1E-05	0.78	0.84	0.80	0.72	0.79
Paradise Cut	PARADSECUT_LEN	10.28	1.6E-07	6.8E-07	89.72	1.6E-11	1.7E-08	0.82	0	0	99.18	0	0	2.39	0	0	97.61	0	0	1.08	0	0	98.92	0	0	0.77	0.84	0.83	0.84	0.82
Port of Stockton	PORTOSTOCK_L0	4.70	0	0	95.30	0	0	2.83	0	0	97.16	0	0	2.20	0	0	97.80	0	0	2.20	0	0	97.79	0	0	0.82	0.83	0.83	0.83	0.83
Sac. R. at Isleton	SACRISLTON_L0	0.55	0	99.45	0.00	0	0	0.18	0	99.82	0.00	0	0	0.45	0	99.55	0.00	0	0	0.41	0	99.59	0	0	8.2E-08	0.09	0.09	0.09	0.09	0.09
Sac River RM 44	SACR44_L0	0.21	0	99.79	0.00	0	0	0.07	0	99.93	0.00	0	0	0.14	0	99.86	0.00	0	0	0.17	0	99.83	0	0	0	0.09	0.09	0.09	0.09	0.09
Sandmound Sl.	SANDMND_MID	10.51	10.17	74.35	4.65	0.25	0.07	5.35	18.03	32.15	44.41	1.5E-04	0.06	5.61	3.13	87.97	2.10	1.17	0.02	3.93	0.55	92.97	0.03	2.45	0.07	0.13	0.43	0.11	0.09	0.19
Sherman Island	SHERMNILND_L0	4.89	5.04	87.74	1.52	0.56	0.23	2.43	14.17	61.17	21.31	0.03	0.89	2.76	1.84	86.03	1.72	7.62	0.04	1.95	0.11	84.69	0.01	11.76	1.48	0.10	0.26	0.10	0.09	0.14
SJR Bowman	SJRBOWMN_MID	1.10	0	0.00	98.90	0	0	0.45	0	0	99.55	0	0	2.06	0	0	97.94	0	0	0.80	0	0	99.20	0	0	0.84	0.85	0.83	0.84	0.84
SJR N Hwy4	SJRNHWY4_MID	1.89	0	0.00	98.11	0	0	0.59	0	0	99.41	0	0	2.64	0	0	97.36	0	0	1.94	0.00	0	98.06	0	0	0.84	0.85	0.83	0.84	0.84
SJR Naval st	SJRNAVLST_L0	4.70	5.45	0.00	89.85	0	0	1.06	5.10	0	93.84	0	0	4.11	9.43	0	86.46	0	0	4.97	12.46	0	82.57	0	0	0.77	0.80	0.75	0.72	0.76
SJR Potato Slough	SJRPOTSL_MID	6.24	16.03	71.18	6.45	0.07	0.03	2.65	23.15	38.61	35.59	1.1E-05	0.01	2.75	2.58	93.40	0.83	0.42	0.01	2.16	1.30	95.35	0.02	1.04	0.13	0.14	0.36	0.10	0.09	0.17
SJR Turner	SJRTURNR_MID	6.75	4.55	1.37	87.31	0.01	0	1.49	3.20	0.00	95.31	0	0	6.05	11.77	4.90	77.27	0.01	8.4E-05	5.55	16.96	10.99	66.44	0.06	7.4E-05	0.76	0.81	0.68	0.60	0.71
SJR/Pt. Antioch/fish pier	ASRANTFSH_MID	4.87	5.29	87.53	1.67	0.37	0.27	2.37	13.56	62.61	20.61	0.02	0.84	2.82	1.68	87.76	1.46	6.24	0.03	2.05	0.14	86.70	0.01	9.68	1.42	0.10	0.25	0.10	0.09	0.14
Suisun Bay	SUISNB_LEN	2.63	1.36	66.87	0.33	28.58	0.23	1.35	6.21	59.91	8.33	22.38	1.82	0.83	0.82	31.47	1.16	65.65	0.07	0.68	0.05	32.01	0.03	66.56	0.68	0.10	0.16	0.11	0.10	0.11
Sycamore Slough	SYCAMOR_MID	14.41	68.02	17.57	8.8E-17	0	3.5E-29	3.66	95.02	1.31	1.E-18	0	3.9E-33	4.79	40.41	54.81	2.9E-20	0	1.1E-32	5.24	32.04	62.72	2.6E-18	7.7E-14	1.0E-30	0.10	0.10	0.09	0.09	0.10
White Slough	WHITESL_L0	47.62	12.39	33.06	6.93	8.2E-04	2.7E-06	15.95	8.06	2.95	73.04	1.4E-05	1.5E-07	10.03	26.20	63.17	0.61	3.0E-05	8.1E-08	9.32	12.33	78.34	0.01	4.6E-04	4.6E-08	0.15	0.65	0.10	0.09	0.25
White Slough DS Disappointment Sl.	WHTSLDISPONT_LEN	20.77	29.09	44.03	6.11	2.4E-04	3.6E-06	14.40	8.89	3.00	73.72	7.9E-06	0	9.10	26.19	64.27	0.45	3.1E-05	0	6.26	14.39	79.35	1.9E-03	6.8E-04	0	0.14	0.65	0.10	0.09	0.25

Attachment Table 5.F-3. Calculation of Quarterly Average Selenium Concentrations for DSM2 Output Locations Based on Percentage of Flow at Each Location from Different Sources: Year 2007

DSM2 Output Water Location	Location ID	First Quarter Inflow Percentage						Second Quarter Inflow Percentage						Third Quarter Inflow Percentage						Fourth Quarter Inflow Percentage						Estimated Waterborne Selenium Concentrations (µg/L)				
	Inflow Source →	Delta Ag.	East Delta Tributaries	Sac. R.	San Joaq. R.	Martinez/ Suisun Bay	Yolo Bypass	Delta Ag.	East Delta Tributaries	Sac. R.	San Joaq. R.	Martinez/ Suisun Bay	Yolo Bypass	Delta Ag.	East Delta Tributaries	Sac. R.	San Joaq. R.	Martinez/ Suisun Bay	Yolo Bypass	Delta Ag.	East Delta Tributaries	Sac. R.	San Joaq. R.	Martinez/ Suisun Bay	Yolo Bypass					
	Inflow Location →	*Mildred Island, Center*	*Mokelumne Calaveras Cosumnes Rivers*	*Freeport*	*Vernalis*	*San Joaq. R. near Mallard Island*	*Sac. R. below Knights Landing*	*Mildred Island, Center*	*Mokelumne Calaveras Cosumnes Rivers*	*Freeport*	*Vernalis*	*San Joaq. R. near Mallard Island*	*Sac. R. below Knights Landing*	*Mildred Island, Center*	*Mokelumne Calaveras Cosumnes Rivers*	*Freeport*	*Vernalis*	*San Joaq. R. near Mallard Island*	*Sac. R. below Knights Landing*	*Mildred Island, Center*	*Mokelumne Calaveras Cosumnes Rivers*	*Freeport*	*Vernalis*	*San Joaq. R. near Mallard Island*	*Sac. R. below Knights Landing*	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	Annual
	Selenium (µg/L) →	0.11	0.10	0.09	0.58	0.10	0.23	0.11	0.10	0.09	0.58	0.10	0.23	0.11	0.10	0.09	0.58	0.10	0.23	0.11	0.10	0.09	0.58	0.10	0.23					
Big Break	BIGBRK_MID	2.66	1.75	93.01	0.07	2.30	0.21	4.40	3.10	84.13	4.24	1.24	2.89	3.58	0.32	81.60	0.79	9.45	4.27	2.60	0.11	84.06	0.04	8.53	4.65	0.09	0.12	0.10	0.10	0.10
Cache Slough	CACHS_LEN	1.86	1.4E-05	97.14	2.2E-07	2.8E-05	1.01	1.99	5.1E-04	88.84	8.8E-04	1.6E-05	9.17	1.92	9.1E-06	89.20	1.9E-05	1.6E-06	8.88	1.64	1.9E-05	91.73	8.5E-06	5.1E-04	6.62	0.09	0.10	0.10	0.10	0.10
Cache Slough Ryer	CACHSR_MID	2.85	1.8E-06	96.46	4.7E-08	1.5E-05	0.68	2.66	1.2E-04	88.76	1.8E-04	1.4E-06	8.58	2.16	1.5E-05	88.35	3.1E-05	3.1E-07	9.49	1.96	4.5E-06	90.83	2.8E-06	1.9E-04	7.21	0.09	0.10	0.10	0.10	0.10
Cosumnes R.	COSR_LEN	0.00	100.00	0	0	0	0.00	0.01	99.99	0	0	0	0	0.09	99.91	0	0	0	0	0	100.00	0	0	0	0.00	0.10	0.10	0.10	0.10	0.10
Franks Tract	FRANKST_MID	3.85	4.08	90.69	0.32	0.94	0.11	6.16	5.35	77.86	9.10	0.16	1.38	4.86	0.34	88.03	0.84	2.96	2.98	3.19	0.32	91.15	0.17	2.23	2.95	0.09	0.14	0.10	0.10	0.11
Little Holland Tract	LHOLND_L0	29.80	0.00	69.38	1.2E-07	5.3E-05	0.81	22.80	8.0E-05	71.18	1.1E-04	5.2E-06	6.02	18.52	2.4E-05	73.18	0.00	4.9E-07	8.30	21.64	5.2E-07	71.72	1.4E-06	4.9E-05	6.64	0.10	0.10	0.11	0.10	0.10
Middle R Bullfrog	MIDRBULFRG_LEN	8.32	10.69	59.08	21.39	0.48	0.04	9.69	10.67	38.75	40.64	0.03	0.22	8.41	3.92	81.16	4.51	0.87	1.14	5.81	4.90	72.42	15.36	0.57	0.94	0.20	0.29	0.12	0.17	0.19
Mildred Island	MILDDRISL_MID	7.42	11.13	68.24	12.63	0.54	0.04	8.53	10.39	42.57	38.23	0.03	0.25	6.49	1.12	88.25	1.83	1.00	1.30	4.91	4.55	80.81	7.99	0.66	1.08	0.15	0.28	0.10	0.13	0.17
Mok. R. below Cosum.	MOKBCOS_LEN	1.46	98.54	0	0	0	0	6.32	93.68	6.5E-04	0	0	0	15.09	84.81	0.10	6.2E-35	0	0	2.30	97.70	0	0	0	0	0.10	0.10	0.10	0.10	0.10
Mok. R. downstream Cosum.	MOKDCOS_MID	1.46	98.54	0	0	0	0	6.42	93.58	0	0	0	0	15.19	84.81	3.2E-04	0	0	0	2.27	97.73	0	0	0	0	0.10	0.10	0.10	0.10	0.10
Old R near Paradise Cut	OLDRNPARADSEC_MID	3.95	5E-12	3E-06	96.05	1.7E-16	2.5E-17	15.73	1.81	12.66	69.68	0.02	0.10	10.18	1.9E-05	1.6E-04	89.82	6.9E-08	6.5E-07	2.31	9.2E-04	0.01	97.68	0	9.7E-05	0.56	0.43	0.53	0.57	0.52
Paradise Cut	PARADSECUT_LEN	1.91	0	0	98.09	0	0	4.98	0.11	0.61	94.29	6.7E-04	3.7E-03	7.14	0	0	92.86	0	0	1.24	4.1E-03	0.05	98.71	4.1E-04	4.5E-04	0.57	0.55	0.55	0.57	0.56
Port of Stockton	PORTOSTOCK_L0	1.48	0	0	98.52	0	0	2.29	0	0	97.71	0	0	6.32	0.04	0	93.64	0	0	7.16	0.05	0	92.78	0	0	0.57	0.57	0.55	0.55	0.56
Sac. R. at Isleton	SACRISLTON_L0	0.45	0	99.55	0	0	2.1E-06	0.63	8.8E-05	99.36	5.7E-08	0	0.01	0.49	0	99.51	0	0	2.9E-04	0.39	1.0E-08	99.61	0	6.7E-07	0.01	0.09	0.09	0.09	0.09	0.09
Sac River RM 44	SACR44_L0	0.20	0	99.80	0	0	0	0.30	0	99.70	0	0	0	0.15	0	99.85	0	0	0	0.11	0	99.89	0	0	0	0.09	0.09	0.09	0.09	0.09
Sandmound Sl.	SANDMND_MID	4.47	3.23	90.83	0.17	1.17	0.13	7.20	4.64	79.23	6.98	0.23	1.71	6.15	0.39	84.96	0.98	4.06	3.46	3.79	0.22	89.26	0.10	3.11	3.51	0.09	0.13	0.10	0.10	0.10
Sherman Island	SHERMNILND_L0	2.14	0.95	92.16	0.04	4.49	0.23	3.69	2.31	83.94	2.94	4.01	3.11	2.99	0.32	77.36	0.77	14.22	4.34	2.22	0.06	75.89	0.03	17.11	4.68	0.09	0.11	0.10	0.10	0.10
SJR Bowman	SJRBOWMN_MID	0.88	0	0	99.12	0	0	3.52	0	0	96.48	0	0	8.49	2.5E-04	0	91.51	0	0	0.91	0	0	99.09	0	0	0.58	0.56	0.54	0.58	0.56
SJR N Hwy4	SJRNHWY4_MID	1.82	2.8E-08	0	98.18	0	0	4.35	1.4E-07	0	95.65	0	0	12.54	0.08	4.0E-26	87.39	0	0	1.89	1.3E-04	0	98.11	0	0	0.57	0.56	0.52	0.57	0.56
SJR Naval st	SJRNAVLST_L0	4.83	6.83	0	88.35	0	0	5.86	11.12	1.3E-06	83.02	0	0	12.06	40.15	3.4E-03	47.78	6.2E-07	6.3E-06	4.73	6.37	2.5E-04	88.90	5.4E-09	7.0E-09	0.52	0.50	0.33	0.53	0.47
SJR Potato Slough	SJRPOTSL_MID	2.91	5.22	91.00	0.15	0.61	0.10	4.89	5.67	79.70	8.49	0.10	1.16	3.16	0.19	91.86	0.46	1.88	2.44	2.37	0.33	93.43	0.10	1.44	2.33	0.09	0.13	0.10	0.09	0.10
SJR Turner	SJRTURNR_MID	7.22	10.11	10.82	71.76	0.08	0.01	7.49	11.95	7.23	73.31	2.9E-03	0.02	11.09	11.29	65.50	11.02	0.46	0.63	6.16	6.57	36.18	50.55	0.19	0.35	0.44	0.45	0.15	0.34	0.35
SJR/Pt. Antioch/fish pier	ASRANTFSH_MID	2.17	1.01	92.90	0.04	3.62	0.26	3.74	2.30	84.37	3.04	3.24	3.31	3.00	0.27	79.62	0.65	12.05	4.40	2.27	0.07	78.73	0.03	14.08	4.82	0.09	0.11	0.10	0.10	0.10
Suisun Bay	SUISNB_LEN	0.87	0.23	46.77	0.01	51.97	0.14	0.94	0.51	31.58	0.43	65.55	0.98	0.84	0.16	21.30	0.36	76.08	1.25	0.59	0.02	21.39	0.01	76.63	1.36	0.10	0.10	0.10	0.10	0.10
Sycamore Slough	SYCAMOR_MID	10.20	72.58	17.22	5.1E-10	9.7E-14	4.3E-29	13.62	50.90	35.47	0.01	4.0E-09	1.1E-07	5.33	3.90	90.77	1.9E-16	3.8E-25	1.1E-22	3.69	20.36	75.95	6.0E-19	1.1E-37	2.4E-31	0.10	0.10	0.09	0.09	0.10
White Slough	WHITESL_L0	20.35	16.73	61.67	1.25	4.8E-03	2.4E-04	33.31	13.41	23.49	29.78	3.9E-04	3.2E-03	15.53	1.33	83.05	0.09	1.2E-03	2.0E-03	9.35	8.62	81.98	0.04	3.7E-04	7.1E-04	0.10	0.24	0.09	0.09	0.13
White Slough DS Disappointment Sl.	WHTSLDISPONT_LEN	10.09	24.12	65.07	0.71	4.1E-03	1.9E-04	17.00	13.60	32.29	37.10	1.4E-03	0.01	7.70	1.46	90.83	1.5E-03	1.3E-03	2.2E-03	5.21	9.69	85.06	0.03	9.7E-04	2.1E-03	0.10	0.28	0.09	0.09	0.14

Attachment Table 5.F-4. Selenium Bioaccumulation from Water (µg/L) to Particulates and Fish (µg/g, dw) Using Models 1 and 2

	Year 2000								Year 2005								Year 2007							
	Concentration					Whole-body	Fish-to-Bass Ratio		Concentration					Whole-body	Fish-to-Bass Ratio		Concentration					Whole-body	Fish-to-Bass Ratio	
DSM2 Delta Water Location	DSM2 Water	Particulate from Water	Invert. from Particulate	Model 1 Fish	Model 2 Fish	Bass[a]	Model 1	Model 2	DSM2 Water	Particulate from Water	Invert. from Particulate	Model 1 Fish	Model 2 Fish	Bass[a]	Model 1	Model 2	DSM2 Water	Particulate from Water	Invert. from Particulate	Model 1 Fish	Model 2 Fish	Bass[a]	Model 1	Model 2
	First Quarter								**First Quarter**								**First Quarter**							
Sacramento River RM 44	0.09	0.09	0.25	0.27	0.30	2.6	0.10	0.11	0.09	0.09	0.25	0.28	0.31	1.5	0.19	0.21	0.09	0.09	0.25	0.28	0.31	1.8	0.15	0.17
Cache Slough Ryer[b]	0.10	0.10	0.28	0.31	0.34	1.5	0.21	0.23	0.09	0.09	0.26	0.29	0.31	1.7	0.17	0.18	0.09	0.09	0.26	0.28	0.31	2.5	0.11	0.12
San Joaquin River Potato Slough	0.17	0.17	0.47	0.52	0.57	1.4	0.38	0.42	0.14	0.14	0.40	0.44	0.48	1.3	0.33	0.37	0.09	0.09	0.26	0.28	0.31	2.5	0.11	0.13
Franks Tract	0.19	0.19	0.53	0.58	0.64	1.6	0.35	0.39	0.15	0.15	0.41	0.45	0.49	1.1	0.39	0.43	0.09	0.09	0.26	0.29	0.32	3.0	0.10	0.11
Big Break	0.13	0.13	0.35	0.39	0.43	1.6	0.25	0.28	0.11	0.11	0.31	0.34	0.37	1.0	0.33	0.37	0.09	0.09	0.26	0.28	0.31	2.8	0.10	0.11
Middle River Bullfrog	0.31	0.31	0.86	0.95	1.05	NA	NA	NA	0.46	0.46	1.29	1.42	1.56	1.9	0.7	0.8	0.20	0.20	0.55	0.61	0.67	2.1	0.3	0.3
Old River near Paradise Cut[c]	0.73	0.73	2.05	2.25	2.48	NA	NA	NA	0.78	0.78	2.19	2.41	2.66	2.4	1.0	1.1	0.56	0.56	1.57	1.73	1.90	NA	NA	NA
Knights Landing[d]	0.23	0.23	0.64	0.71	0.78	NA	NA	NA	0.23	0.23	0.64	0.71	0.78	2.2	0.3	0.4	0.23	0.23	0.64	0.71	0.78	NA	NA	NA
Vernalis[e]	0.83	0.83	2.32	2.56	2.81	1.7	1.50	1.65	0.85	0.85	2.38	2.62	2.88	1.9	1.38	1.52	0.58	0.58	1.62	1.79	1.97	2.4	0.74	0.82
	Second Quarter								**Second Quarter**								**Second Quarter**							
Sacramento River RM 44	0.09	0.09	0.25	0.28	0.30	2.6	0.11	0.12	0.09	0.09	0.25	0.28	0.30	1.5	0.19	0.21	0.09	0.09	0.25	0.28	0.31	1.8	0.15	0.17
Cache Slough Ryer[b]	0.11	0.11	0.32	0.35	0.38	1.5	0.23	0.26	0.10	0.10	0.27	0.30	0.33	1.7	0.17	0.19	0.10	0.10	0.29	0.32	0.35	2.5	0.12	0.14
San Joaquin River Potato Slough	0.24	0.24	0.67	0.74	0.81	1.4	0.54	0.60	0.36	0.36	1.02	1.12	1.23	1.3	0.86	0.94	0.13	0.13	0.38	0.42	0.46	2.5	0.17	0.18
Franks Tract	0.27	0.27	0.76	0.83	0.92	1.6	0.51	0.56	0.49	0.49	1.36	1.50	1.65	1.1	1.31	1.44	0.14	0.14	0.39	0.43	0.47	3.0	0.14	0.16
Big Break	0.20	0.20	0.55	0.60	0.66	1.6	0.39	0.43	0.30	0.30	0.83	0.91	1.00	1.0	0.89	0.98	0.12	0.12	0.33	0.36	0.39	2.8	0.13	0.14
Middle River Bullfrog	0.61	0.61	1.71	1.88	2.07	NA	NA	NA	0.75	0.75	2.09	2.30	2.53	1.9	1.2	1.3	0.29	0.29	0.82	0.90	0.99	2.1	0.4	0.5
Old River near Paradise Cut[c]	0.68	0.68	1.89	2.08	2.29	NA	NA	NA	0.84	0.84	2.35	2.59	2.84	2.4	1.1	1.2	0.43	0.43	1.22	1.34	1.47	NA	NA	NA
Knights Landing[d]	0.23	0.23	0.64	0.71	0.78	NA	NA	NA	0.23	0.23	0.64	0.71	0.78	2.2	0.3	0.4	0.23	0.23	0.64	0.71	0.78	NA	NA	NA
Vernalis[e]	0.83	0.83	2.32	2.56	2.81	1.7	1.50	1.65	0.85	0.85	2.38	2.62	2.88	1.9	1.38	1.52	0.58	0.58	1.62	1.79	1.97	2.4	0.74	0.82
	Third Quarter								**Third Quarter**								**Third Quarter**							
Sacramento River RM 44	0.09	0.09	0.25	0.28	0.30	2.6	0.11	0.12	0.09	0.09	0.25	0.28	0.31	1.5	0.19	0.21	0.09	0.09	0.25	0.28	0.31	1.8	0.15	0.17
Cache Slough Ryer[b]	0.11	0.11	0.31	0.34	0.37	1.5	0.22	0.25	0.09	0.09	0.25	0.28	0.31	1.7	0.16	0.18	0.10	0.10	0.29	0.32	0.35	2.5	0.13	0.14
San Joaquin River Potato Slough	0.10	0.10	0.27	0.30	0.32	1.4	0.22	0.24	0.10	0.10	0.27	0.30	0.33	1.3	0.23	0.25	0.10	0.10	0.27	0.30	0.33	2.5	0.12	0.13
Franks Tract	0.10	0.10	0.28	0.31	0.34	1.6	0.19	0.20	0.11	0.11	0.29	0.32	0.36	1.1	0.28	0.31	0.10	0.10	0.28	0.31	0.34	3.0	0.10	0.11
Big Break	0.10	0.10	0.29	0.32	0.35	1.6	0.20	0.22	0.10	0.10	0.29	0.32	0.35	1.0	0.31	0.35	0.10	0.10	0.28	0.31	0.34	2.8	0.11	0.12
Middle River Bullfrog	0.20	0.20	0.57	0.63	0.69	NA	NA	NA	0.30	0.30	0.83	0.91	1.01	1.9	0.5	0.5	0.12	0.12	0.32	0.36	0.39	2.1	0.2	0.2
Old River near Paradise Cut[c]	0.75	0.75	2.11	2.32	2.55	NA	NA	NA	0.80	0.80	2.24	2.47	2.71	2.4	1.0	1.1	0.53	0.53	1.49	1.64	1.80	NA	NA	NA
Knights Landing[d]	0.23	0.23	0.64	0.71	0.78	NA	NA	NA	0.23	0.23	0.64	0.71	0.78	2.2	0.3	0.4	0.23	0.23	0.64	0.71	0.78	NA	NA	NA
Vernalis[e]	0.83	0.83	2.32	2.56	2.81	1.7	1.50	1.65	0.85	0.85	2.38	2.62	2.88	1.9	1.38	1.52	0.58	0.58	1.62	1.79	1.97	2.4	0.74	0.82
	Fourth Quarter								**Fourth Quarter**								**Fourth Quarter**							
Sacramento River RM 44	0.09	0.09	0.25	0.28	0.30	2.6	0.11	0.12	0.09	0.09	0.25	0.28	0.31	1.5	0.19	0.21	0.09	0.09	0.25	0.28	0.30	1.8	0.15	0.17
Cache Slough Ryer[b]	0.10	0.10	0.29	0.31	0.35	1.5	0.21	0.23	0.09	0.09	0.26	0.28	0.31	1.7	0.16	0.18	0.10	0.10	0.28	0.31	0.34	2.5	0.12	0.13
San Joaquin River Potato Slough	0.09	0.09	0.26	0.29	0.32	1.4	0.21	0.23	0.09	0.09	0.25	0.28	0.31	1.3	0.21	0.24	0.09	0.09	0.26	0.29	0.32	2.5	0.12	0.13
Franks Tract	0.10	0.10	0.27	0.29	0.32	1.6	0.18	0.20	0.09	0.09	0.26	0.28	0.31	1.1	0.25	0.27	0.10	0.10	0.27	0.30	0.32	3.0	0.10	0.11
Big Break	0.10	0.10	0.27	0.30	0.33	1.6	0.19	0.21	0.09	0.09	0.26	0.28	0.31	1.0	0.28	0.31	0.10	0.10	0.27	0.30	0.33	2.8	0.11	0.12
Middle River Bullfrog	0.30	0.30	0.84	0.92	1.01	NA	NA	NA	0.24	0.24	0.68	0.74	0.82	1.9	0.4	0.4	0.17	0.17	0.47	0.52	0.57	2.1	0.2	0.3
Old River near Paradise Cut[c]	0.81	0.81	2.27	2.50	2.75	NA	NA	NA	0.72	0.72	2.01	2.21	2.43	2.4	0.9	1.0	0.57	0.57	1.59	1.75	1.93	NA	NA	NA

Attachment Table 5.F-4. Selenium Bioaccumulation from Water (µg/L) to Particulates and Fish (µg/g, dw) Using Models 1 and 2

DSM2 Delta Water Location	Year 2000							
	Concentration					Whole-body Bass[a]	Fish-to-Bass Ratio	
	DSM2 Water	Particulate from Water	Invert. from Particulate	Model 1 Fish	Model 2 Fish		Model 1	Model 2
Knights Landing[d]	0.23	0.23	0.64	0.71	0.78	NA	NA	NA
Vernalis[e]	0.83	0.83	2.32	2.56	2.81	1.7	1.50	1.65

DSM2 Delta Water Location	Year 2005							
	Concentration					Whole-body Bass[a]	Fish-to-Bass Ratio	
	DSM2 Water	Particulate from Water	Invert. from Particulate	Model 1 Fish	Model 2 Fish		Model 1	Model 2
Knights Landing[d]	0.23	0.23	0.64	0.71	0.78	2.2	0.3	0.4
Vernalis[e]	0.85	0.85	2.38	2.62	2.88	1.9	1.38	1.52

DSM2 Delta Water Location	Year 2007							
	Concentration					Whole-body Bass[a]	Fish-to-Bass Ratio	
	DSM2 Water	Particulate from Water	Invert. from Particulate	Model 1 Fish	Model 2 Fish		Model 1	Model 2
Knights Landing[d]	0.23	0.23	0.64	0.71	0.78	NA	NA	NA
Vernalis[e]	0.58	0.58	1.62	1.79	1.97	2.4	0.74	0.82

Notes:

Equations from Presser and Luoma (2010a, 2010b) were used to calculate selenium concentrations for fish. Models 1 and 2 used the default K_d (1000) and the average selenium trophic transfer factors to aquatic insects (2.8) and fish (1.1 for all trophic levels).

Model 1 = TL-3 Fish Eating Invertebrates

Model 2 = TL-4 Fish Eating TL-3 Fish

Invert. = invertebrate

K_d = particulate concentration/water concentration ratio

µg/g, dw = micrograms per gram, dry weight

NA = not available; bass not collected here

RM = river mile

TL = trophic level

[a] Geometric mean calculated from whole-body largemouth bass data presented in Foe (2010).

[b] Fish data collected at Rio Vista (Foe 2010a) were used to calculate geometric mean whole-body largemouth bass and ratios.

[c] Fish data collected at Old River near Tracy (Foe 2010a) were used to calculate geometric mean whole-body largemouth bass and ratios.

[d] Geometric mean of total selenium concentrations in water collected from years 2004, 2007, and 2008 (DWR Website 2009) was used to estimate selenium concentrations in particulates and biota (DSM2 data were not available). Fish data collected from Sacramento River at Veterans Bridge (Foe 2010a) were used to calculate geometric mean whole-body largemouth bass and ratios.

[e] Geometric mean of selenium concentrations (total or dissolved was not specified) in water collected from years 1999–2000 (SWAMP Website 2009) was used to estimate Year 2000 selenium concentrations in particulates and biota (DSM2 data were not available); years 2004-2005 were used for Year 2005 estimates; and years 2006-2007 were used for Year 2007 estimates.

Attachment Table 5.F-5. Selenium Bioaccumulation from Water (µg/L) to Particulates and Fish (µg/g, dw) Using Model 2 with Estimated Kd from All Years Regression for Model 3

DSM2 Delta Water Location	Year 2000							Year 2005							Year 2007						
	Concentration					Whole-body Bass[a]	Fish-to-Bass Ratio	Concentration					Whole-body Bass[a]	Fish-to-Bass Ratio	Concentration					Whole-body Bass[a]	Fish-to-Bass Ratio
	DSM2 Water	Particulate from Water	Invert. from Particulate	Model 3 Fish	K_d		Model 3	DSM2 Water	Particulate from Water	Invert. from Particulate	Model 3 Fish	K_d		Model 3	DSM2 Water	Particulate from Water	Invert. from Particulate	Model 3 Fish	K_d		Model 3
First Quarter																					
Sacramento River RM 44	0.09	0.54	1.51	1.82	6091	2.6	0.69	0.09	0.54	1.51	1.82	5970	1.5	1.25	0.09	0.54	1.51	1.82	5971	1.8	0.99
Cache Slough Ryer[b]	0.10	0.54	1.50	1.82	5390	1.5	1.22	0.09	0.54	1.50	1.82	5801	1.7	1.05	0.09	0.54	1.51	1.82	5873	2.5	0.72
San Joaquin River Potato Slough	0.17	0.53	1.50	1.81	3162	1.4	1.33	0.14	0.54	1.50	1.81	3771	1.3	1.39	0.09	0.54	1.50	1.82	5839	2.5	0.73
Franks Tract	0.19	0.53	1.49	1.81	2832	1.6	1.10	0.15	0.54	1.50	1.81	3669	1.1	1.58	0.09	0.54	1.50	1.82	5779	3.0	0.61
Big Break	0.13	0.54	1.50	1.82	4255	1.6	1.17	0.11	0.54	1.50	1.82	4854	1.0	1.78	0.09	0.54	1.51	1.82	5871	2.8	0.64
Middle River Bullfrog	0.31	0.53	1.49	1.80	1721	NA	NA	0.46	0.53	1.48	1.79	1149	1.9	0.9	0.20	0.53	1.49	1.81	2699	2.1	0.85
Old River near Paradise Cut[c]	0.73	0.53	1.47	1.78	720	NA	NA	0.78	0.53	1.47	1.78	671	2.4	0.7	0.56	0.53	1.48	1.79	940	NA	NA
Knights Landing[d]	0.23	0.53	1.49	1.80	2316	NA	NA	0.23	0.53	1.49	1.80	2316	2.2	0.8	0.23	0.53	1.49	1.80	2316	NA	NA
Vernalis[e]	0.83	0.53	1.47	1.78	633	1.2	1.48	0.85	0.53	1.47	1.78	618	1.9	0.94	0.58	0.53	1.48	1.79	910	2.4	0.74
Second Quarter																					
Sacramento River RM 44	0.09	0.54	1.51	1.82	5977	2.6	0.69	0.09	0.54	1.51	1.82	5972	1.5	1.25	0.09	0.54	1.51	1.82	5969	1.8	0.99
Cache Slough Ryer[b]	0.11	0.54	1.50	1.82	4754	1.5	1.22	0.10	0.54	1.50	1.82	5545	1.7	1.05	0.10	0.54	1.50	1.82	5236	2.5	0.71
San Joaquin River Potato Slough	0.24	0.53	1.49	1.80	2230	1.4	1.33	0.36	0.53	1.48	1.80	1459	1.3	1.37	0.13	0.54	1.50	1.81	3973	2.5	0.73
Franks Tract	0.27	0.53	1.49	1.80	1968	1.6	1.09	0.49	0.53	1.48	1.79	1088	1.1	1.56	0.14	0.54	1.50	1.81	3871	3.0	0.61
Big Break	0.20	0.53	1.49	1.81	2726	1.6	1.17	0.30	0.53	1.49	1.80	1796	1.0	1.76	0.12	0.54	1.50	1.82	4618	2.8	0.64
Middle River Bullfrog	0.61	0.53	1.48	1.79	863	NA	NA	0.75	0.53	1.47	1.78	705	1.9	0.9	0.29	0.53	1.49	1.80	1817	2.1	0.8
Old River near Paradise Cut[c]	0.68	0.53	1.48	1.79	780	NA	NA	0.84	0.53	1.47	1.78	626	2.4	0.7	0.43	0.53	1.48	1.79	1217	NA	NA
Knights Landing[d]	0.23	0.53	1.49	1.80	2316	NA	NA	0.23	0.53	1.49	1.80	2316	2.2	0.8	0.23	0.53	1.49	1.80	2316	NA	NA
Vernalis[e]	0.83	0.53	1.47	1.78	633	1.2	1.48	0.85	0.53	1.47	1.78	618	1.9	0.94	0.58	0.53	1.48	1.79	910	2.4	0.74
Third Quarter																					
Sacramento River RM 44	0.09	0.54	1.51	1.82	5972	2.6	0.69	0.09	0.54	1.51	1.82	5971	1.5	1.25	0.09	0.54	1.51	1.82	5971	1.8	0.99
Cache Slough Ryer[b]	0.11	0.54	1.50	1.82	4925	1.5	1.22	0.09	0.54	1.51	1.82	5938	1.7	1.05	0.10	0.54	1.50	1.82	5176	2.5	0.71
San Joaquin River Potato Slough	0.10	0.54	1.50	1.82	5601	1.4	1.34	0.10	0.54	1.50	1.82	5529	1.3	1.39	0.10	0.54	1.50	1.82	5565	2.5	0.73
Franks Tract	0.10	0.54	1.50	1.82	5413	1.6	1.11	0.11	0.54	1.50	1.82	5111	1.1	1.59	0.10	0.54	1.50	1.82	5394	3.0	0.61
Big Break	0.10	0.54	1.50	1.82	5222	1.6	1.17	0.10	0.54	1.50	1.82	5151	1.0	1.78	0.10	0.54	1.50	1.82	5287	2.8	0.64
Middle River Bullfrog	0.20	0.53	1.49	1.81	2612	NA	NA	0.30	0.53	1.49	1.80	1788	1.9	0.9	0.12	0.54	1.50	1.82	4629	2.1	0.85
Old River near Paradise Cut[c]	0.75	0.53	1.47	1.78	698	NA	NA	0.80	0.53	1.47	1.78	657	2.4	0.7	0.53	0.53	1.48	1.79	992	NA	NA
Knights Landing[d]	0.23	0.53	1.49	1.80	2316	NA	NA	0.23	0.53	1.49	1.80	2316	2.2	0.8	0.23	0.53	1.49	1.80	2316	NA	NA
Vernalis[e]	0.83	0.53	1.47	1.78	633	1.2	1.48	0.85	0.53	1.47	1.78	618	1.9	0.94	0.58	0.53	1.48	1.79	910	2.4	0.74
Fourth Quarter																					
Sacramento River RM 44	0.09	0.54	1.51	1.82	5973	2.6	0.69	0.09	0.54	1.51	1.82	5971	1.5	1.25	0.09	0.54	1.51	1.82	5972	1.8	0.99
Cache Slough Ryer[b]	0.10	0.54	1.50	1.82	5257	1.5	1.22	0.09	0.54	1.50	1.82	5850	1.7	1.05	0.10	0.54	1.50	1.82	5344	2.5	0.71
San Joaquin River Potato Slough	0.09	0.54	1.50	1.82	5718	1.4	1.34	0.09	0.54	1.51	1.82	5907	1.3	1.39	0.09	0.54	1.50	1.82	5692	2.5	0.73
Franks Tract	0.10	0.54	1.50	1.82	5631	1.6	1.11	0.09	0.54	1.51	1.82	5880	1.1	1.59	0.10	0.54	1.50	1.82	5605	3.0	0.61
Big Break	0.10	0.54	1.50	1.82	5541	1.6	1.17	0.09	0.54	1.50	1.82	5828	1.0	1.79	0.10	0.54	1.50	1.82	5475	2.8	0.64
Middle River Bullfrog	0.30	0.53	1.49	1.80	1779	NA	NA	0.24	0.53	1.49	1.80	2204	1.9	0.9	0.17	0.53	1.50	1.81	3175	2.1	0.85
Old River near Paradise Cut[c]	0.81	0.53	1.47	1.78	648	NA	NA	0.72	0.53	1.47	1.78	735	2.4	0.7	0.57	0.53	1.48	1.79	927	NA	NA

Attachment Table 5.F-5. Selenium Bioaccumulation from Water (µg/L) to Particulates and Fish (µg/g, dw) Using Model 2 with Estimated Kd from All Years Regression for Model 3

	Year 2000							Year 2005							Year 2007						
	Concentration					Whole-body Bass[a]	Fish-to-Bass Ratio	Concentration					Whole-body Bass[a]	Fish-to-Bass Ratio	Concentration					Whole-body Bass[a]	Fish-to-Bass Ratio
DSM2 Delta Water Location	DSM2 Water	Particulate from Water	Invert. from Particulate	Model 3 Fish	K_d		Model 3	DSM2 Water	Particulate from Water	Invert. from Particulate	Model 3 Fish	K_d		Model 3	DSM2 Water	Particulate from Water	Invert. from Particulate	Model 3 Fish	K_d		Model 3
Knights Landing[d]	0.23	0.53	1.49	1.80	2316	NA	NA	0.23	0.53	1.49	1.80	2316	2.2	0.8	0.23	0.53	1.49	1.80	2316	NA	NA
Vernalis[e]	0.83	0.53	1.47	1.78	633	1.2	1.48	0.85	0.53	1.47	1.78	618	1.9	0.94	0.58	0.53	1.48	1.79	910	2.4	0.74

Notes:

Equations from Presser and Luoma (2010a, 2010b) were used to calculate selenium concentrations for fish. Model 3 used the average selenium trophic transfer factors to aquatic insects (2.8) and fish (1.1 for all trophic levels).

Model 3 = Model 2 (TL-4 Fish Eating TL-3 Fish) with K_d estimated using all years regression (log K_d = 2.72-1.01(logDSM2))

Invert. = invertebrate

K_d = particulate concentration/water concentration ratio

µg/g, dw = micrograms per gram, dry weight

NA = not available; bass not collected here

RM = river mile

TL = trophic level

[a] Geometric mean calculated from whole-body largemouth bass data presented in Foe (2010).

[b] Fish data collected at Rio Vista (Foe 2010a) were used to calculate geometric mean whole-body largemouth bass and ratios.

[c] Fish data collected at Old River near Tracy (Foe 2010a) were used to calculate geometric mean whole-body largemouth bass and ratios.

[d] Geometric mean of total selenium concentrations in water collected from years 2004, 2007, and 2008 (DWR Website 2009) was used to estimate selenium concentrations in particulates and biota (DSM2 data were not available). Fish data collected from Sacramento River at Veterans Bridge (Foe 2010a) were used to calculate geometric mean whole-body largemouth bass and ratios.

[e] Geometric mean of selenium concentrations (total or dissolved was not specified) in water collected from years 1999–2000 (SWAMP Website 2009) was used to estimate Year 2000 selenium concentrations in particulates and biota (DSM2 data were not available); years 2004-2005 were used for Year 2005 estimates; and years 2006-2007 were used for Year 2007 estimates.

Attachment Table 5.F-6. Selenium Bioaccumulation from Water (µg/L) to Particulates and Fish (µg/g, dw) Using Model 2 with Estimated Kd from Normal/Wet Years Regression for Model 4 and Dry Years Regression for Model 5

Year 2000

DSM2 Delta Water Location	Concentration: DSM2 Water	Concentration: Particulate from Water	Concentration: Invert. from Particulate	Concentration: Model 4 Fish	K_d	Whole-body Bass[a]	Fish-to-Bass Ratio: Model 4
First Quarter							
Sacramento River RM 44	0.09	0.45	1.27	1.54	5145	2.6	0.58
Cache Slough Ryer[b]	0.10	0.46	1.28	1.55	4586	1.5	1.04
San Joaquin River Potato Slough	0.17	0.47	1.31	1.59	2777	1.4	1.17
Franks Tract	0.19	0.47	1.32	1.60	2504	1.6	0.97
Big Break	0.13	0.46	1.29	1.57	3672	1.6	1.01
Middle River Bullfrog	0.31	0.48	1.35	1.64	1568	NA	NA
Old River near Paradise Cut[c]	0.73	0.50	1.41	1.71	691	NA	NA
Knights Landing[d]	0.23	0.48	1.33	1.61	2072	NA	NA
Vernalis[e]	0.83	0.51	1.42	1.72	612	1.2	1.43
Second Quarter							
Sacramento River RM 44	0.09	0.45	1.27	1.54	5055	2.6	0.58
Cache Slough Ryer[b]	0.11	0.46	1.29	1.56	4076	1.5	1.04
San Joaquin River Potato Slough	0.24	0.48	1.34	1.62	1999	1.4	1.19
Franks Tract	0.27	0.48	1.35	1.63	1778	1.6	0.99
Big Break	0.20	0.47	1.32	1.60	2415	1.6	1.03
Middle River Bullfrog	0.61	0.50	1.40	1.70	819	NA	NA
Old River near Paradise Cut[c]	0.68	0.50	1.41	1.70	745	NA	NA
Knights Landing[d]	0.23	0.48	1.33	1.61	2072	NA	NA
Vernalis[e]	0.83	0.51	1.42	1.72	612	1.2	1.43
Third Quarter							
Sacramento River RM 44	0.09	0.45	1.27	1.54	5051	2.6	0.58
Cache Slough Ryer[b]	0.11	0.46	1.29	1.56	4214	1.5	1.04
San Joaquin River Potato Slough	0.10	0.46	1.28	1.55	4755	1.4	1.14
Franks Tract	0.10	0.46	1.28	1.55	4605	1.6	0.94
Big Break	0.10	0.46	1.28	1.55	4452	1.6	1.00
Middle River Bullfrog	0.20	0.47	1.33	1.60	2320	NA	NA
Old River near Paradise Cut[c]	0.75	0.51	1.42	1.71	671	NA	NA
Knights Landing[d]	0.23	0.48	1.33	1.61	2072	NA	NA
Vernalis[e]	0.83	0.51	1.42	1.72	612	1.2	1.43
Fourth Quarter							
Sacramento River RM 44	0.09	0.45	1.27	1.54	5052	2.6	0.58
Cache Slough Ryer[b]	0.10	0.46	1.28	1.55	4480	1.5	1.04
San Joaquin River Potato Slough	0.09	0.46	1.28	1.54	4849	1.4	1.14
Franks Tract	0.10	0.46	1.28	1.54	4780	1.6	0.94
Big Break	0.10	0.46	1.28	1.55	4708	1.6	1.00
Middle River Bullfrog	0.30	0.48	1.35	1.64	1617	NA	NA
Old River near Paradise Cut[c]	0.81	0.51	1.42	1.72	625	NA	NA
Knights Landing[d]	0.23	0.48	1.33	1.61	2072	NA	NA

Year 2005

DSM2 Delta Water Location	Concentration: DSM2 Water	Concentration: Particulate from Water	Concentration: Invert. from Particulate	Concentration: Model 4 Fish	K_d	Whole-body Bass[a]	Fish-to-Bass Ratio: Model 4
First Quarter							
Sacramento River RM 44	0.09	0.45	1.27	1.54	5050	1.5	1.06
Cache Slough Ryer[b]	0.09	0.46	1.27	1.54	4915	1.7	0.89
San Joaquin River Potato Slough	0.14	0.47	1.30	1.58	3278	1.3	1.20
Franks Tract	0.15	0.47	1.30	1.58	3194	1.1	1.38
Big Break	0.11	0.46	1.29	1.56	4156	1.0	1.53
Middle River Bullfrog	0.46	0.49	1.38	1.67	1072	1.9	0.9
Old River near Paradise Cut[c]	0.78	0.51	1.42	1.72	646	2.4	0.7
Knights Landing[d]	0.23	0.48	1.33	1.61	2072	2.2	0.7
Vernalis[e]	0.85	0.51	1.42	1.72	598	1.9	0.91
Second Quarter							
Sacramento River RM 44	0.09	0.45	1.27	1.54	5051	1.5	1.06
Cache Slough Ryer[b]	0.10	0.46	1.28	1.55	4711	1.7	0.89
San Joaquin River Potato Slough	0.36	0.49	1.37	1.65	1342	1.3	1.26
Franks Tract	0.49	0.49	1.39	1.68	1018	1.1	1.46
Big Break	0.30	0.48	1.35	1.63	1632	1.0	1.60
Middle River Bullfrog	0.75	0.51	1.42	1.71	677	1.9	0.9
Old River near Paradise Cut[c]	0.84	0.51	1.42	1.72	606	2.4	0.7
Knights Landing[d]	0.23	0.48	1.33	1.61	2072	2.2	0.7
Vernalis[e]	0.85	0.51	1.42	1.72	598	1.9	0.91
Third Quarter							
Sacramento River RM 44	0.09	0.45	1.27	1.54	5051	1.5	1.06
Cache Slough Ryer[b]	0.09	0.45	1.27	1.54	5024	1.7	0.89
San Joaquin River Potato Slough	0.10	0.46	1.28	1.55	4698	1.3	1.18
Franks Tract	0.11	0.46	1.28	1.55	4363	1.1	1.36
Big Break	0.10	0.46	1.28	1.55	4395	1.0	1.52
Middle River Bullfrog	0.30	0.48	1.35	1.64	1625	1.9	0.9
Old River near Paradise Cut[c]	0.80	0.51	1.42	1.72	633	2.4	0.7
Knights Landing[d]	0.23	0.48	1.33	1.61	2072	2.2	0.7
Vernalis[e]	0.85	0.51	1.42	1.72	598	1.9	0.91
Fourth Quarter							
Sacramento River RM 44	0.09	0.45	1.27	1.54	5050	1.5	1.06
Cache Slough Ryer[b]	0.09	0.46	1.27	1.54	4954	1.7	0.89
San Joaquin River Potato Slough	0.09	0.45	1.27	1.54	4999	1.3	1.18
Franks Tract	0.09	0.46	1.27	1.54	4978	1.1	1.35
Big Break	0.09	0.46	1.27	1.54	4936	1.0	1.51
Middle River Bullfrog	0.24	0.48	1.34	1.62	1978	1.9	0.8
Old River near Paradise Cut[c]	0.72	0.50	1.41	1.71	704	2.4	0.7
Knights Landing[d]	0.23	0.48	1.33	1.61	2072	2.2	0.7

Year 2007

DSM2 Delta Water Location	Concentration: DSM2 Water	Concentration: Particulate from Water	Concentration: Invert. from Particulate	Concentration: Model 5 Fish	K_d	Whole-body Bass[a]	Fish-to-Bass Ratio: Model 5
First Quarter							
Sacramento River RM 44	0.09	0.73	2.03	2.46	8063	1.8	1.33
Cache Slough Ryer[b]	0.09	0.73	2.03	2.46	7929	2.5	0.97
San Joaquin River Potato Slough	0.09	0.73	2.03	2.46	7883	2.5	0.99
Franks Tract	0.09	0.73	2.03	2.46	7802	3.0	0.82
Big Break	0.09	0.73	2.03	2.46	7926	2.8	0.87
Middle River Bullfrog	0.20	0.71	2.00	2.42	3616	2.1	1.14
Old River near Paradise Cut[c]	0.56	0.70	1.96	2.37	1247	NA	NA
Knights Landing[d]	0.23	0.71	1.99	2.41	3098	NA	NA
Vernalis[e]	0.58	0.70	1.96	2.37	1206	2.4	0.99
Second Quarter							
Sacramento River RM 44	0.09	0.73	2.03	2.46	8061	1.8	1.33
Cache Slough Ryer[b]	0.10	0.72	2.03	2.45	7061	2.5	0.96
San Joaquin River Potato Slough	0.13	0.72	2.02	2.44	5343	2.5	0.98
Franks Tract	0.14	0.72	2.02	2.44	5204	3.0	0.82
Big Break	0.12	0.72	2.02	2.45	6220	2.8	0.86
Middle River Bullfrog	0.29	0.71	1.99	2.40	2424	2.1	1.1
Old River near Paradise Cut[c]	0.43	0.70	1.97	2.38	1617	NA	NA
Knights Landing[d]	0.23	0.71	1.99	2.41	3098	NA	NA
Vernalis[e]	0.58	0.70	1.96	2.37	1206	2.4	0.99
Third Quarter							
Sacramento River RM 44	0.09	0.73	2.03	2.46	8064	1.8	1.33
Cache Slough Ryer[b]	0.10	0.72	2.03	2.45	6980	2.5	0.96
San Joaquin River Potato Slough	0.10	0.72	2.03	2.46	7510	2.5	0.99
Franks Tract	0.10	0.72	2.03	2.45	7276	3.0	0.82
Big Break	0.10	0.72	2.03	2.45	7131	2.8	0.87
Middle River Bullfrog	0.12	0.72	2.02	2.45	6235	2.1	1.15
Old River near Paradise Cut[c]	0.53	0.70	1.96	2.37	1317	NA	NA
Knights Landing[d]	0.23	0.71	1.99	2.41	3098	NA	NA
Vernalis[e]	0.58	0.70	1.96	2.37	1206	2.4	0.99
Fourth Quarter							
Sacramento River RM 44	0.09	0.73	2.03	2.46	8064	1.8	1.33
Cache Slough Ryer[b]	0.10	0.72	2.03	2.45	7209	2.5	0.96
San Joaquin River Potato Slough	0.09	0.73	2.03	2.46	7682	2.5	0.99
Franks Tract	0.10	0.73	2.03	2.46	7564	3.0	0.82
Big Break	0.10	0.72	2.03	2.46	7386	2.8	0.87
Middle River Bullfrog	0.17	0.72	2.01	2.43	4260	2.1	1.14
Old River near Paradise Cut[c]	0.57	0.70	1.96	2.37	1229	NA	NA
Knights Landing[d]	0.23	0.71	1.99	2.41	3098	NA	NA

Attachment Table 5.F-6. Selenium Bioaccumulation from Water (µg/L) to Particulates and Fish (µg/g, dw) Using Model 2 with Estimated Kd from Normal/Wet Years Regression for Model 4 and Dry Years Regression for Model 5

DSM2 Delta Water Location	Year 2000							Year 2005							Year 2007						
	Concentration					Whole-body Bass[a]	Fish-to-Bass Ratio	Concentration					Whole-body Bass[a]	Fish-to-Bass Ratio	Concentration					Whole-body Bass[a]	Fish-to-Bass Ratio
	DSM2 Water	Particulate from Water	Invert. from Particulate	Model 4 Fish	K_d		Model 4	DSM2 Water	Particulate from Water	Invert. from Particulate	Model 4 Fish	K_d		Model 4	DSM2 Water	Particulate from Water	Invert. from Particulate	Model 5 Fish	K_d		Model 5
Vernalis[e]	0.83	0.51	1.42	1.72	612	1.2	1.43	0.85	0.51	1.42	1.72	598	1.9	0.91	0.58	0.70	1.96	2.37	1206	2.4	0.99

Notes:

Equations from Presser and Luoma (2010a, 2010b) were used to calculate selenium concentrations for fish. Models 4 and 5 used the average selenium trophic transfer factors to aquatic insects (2.8) and fish (1.1 for all trophic levels).

Model 4 = Model 2 (TL-4 Fish Eating TL-3 Fish) with K_d estimated using normal/wet years regression (log K_d = 2.71-0.95(logDSM2))

Model 5 = Model 2 (TL-4 Fish Eating TL-3 Fish) with K_d estimated using dry years (2007) regression (log K_d = 2.84-1.02(logDSM2))

Invert. = invertebrate

K_d = particulate concentration/water concentration ratio

µg/g, dw = micrograms per gram, dry weight

NA = not available; bass not collected here

RM = river mile

TL = trophic level

[a] Geometric mean calculated from whole-body largemouth bass data presented in Foe (2010).

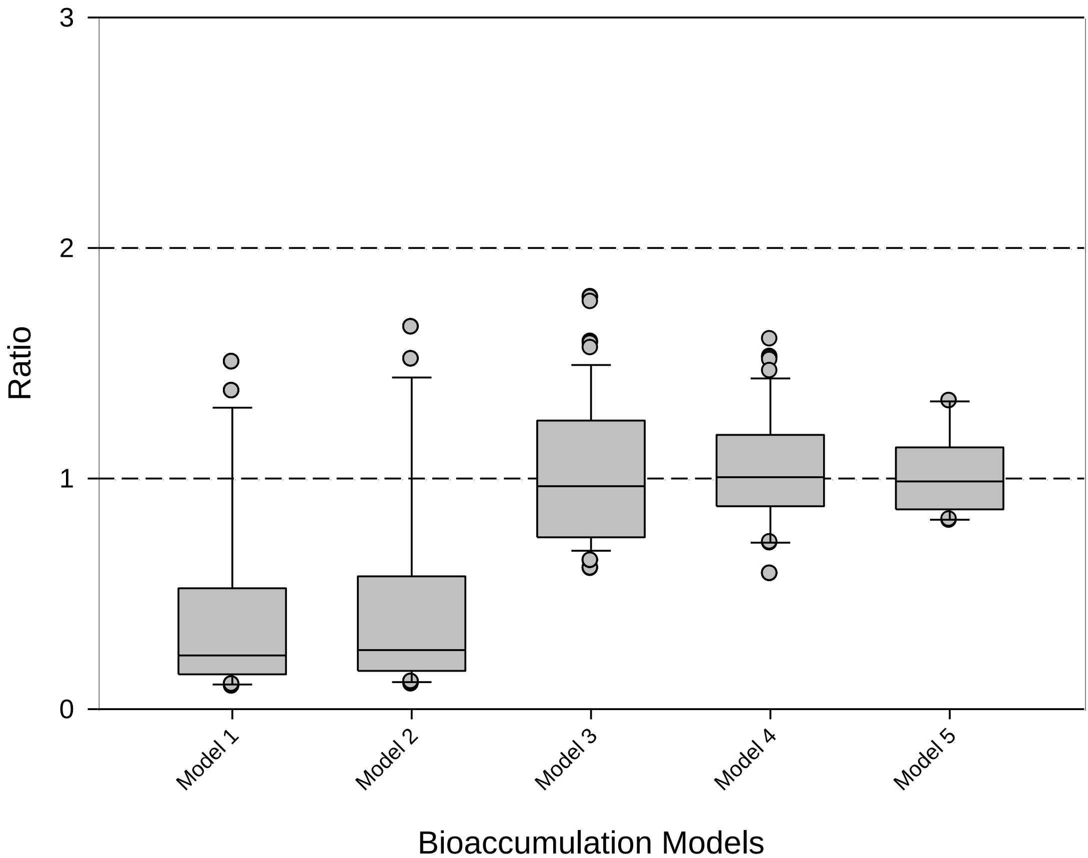
[b] Fish data collected at Rio Vista (Foe 2010a) were used to calculate geometric mean whole-body largemouth bass and ratios.

[c] Fish data collected at Old River near Tracy (Foe 2010a) were used to calculate geometric mean whole-body largemouth bass and ratios.

[d] Geometric mean of total selenium concentrations in water collected from years 2004, 2007, and 2008 (DWR Website 2009) was used to estimate selenium concentrations in particulates and biota (DSM2 data were not available). Fish data collected from Sacramento River at Veterans Bridge (Foe 2010a) were used to calculate geometric mean whole-body largemouth bass and ratios.

[e] Geometric mean of selenium concentrations (total or dissolved was not specified) in water collected from years 1999–2000 (SWAMP Website 2009) was used to estimate Year 2000 selenium concentrations in particulates and biota (DSM2 data were not available); years 2004-2005 were used for Year 2005 estimates; and years 2006-2007 were used for Year 2007 estimates.

Attachment Figure 5.F-1. Ratios of Predicted Selenium Concentrations in Fish Models 1 through 5 to Observed Selenium Concentrations in Largemouth Bass



For Models 1 and 2, default values (K_d = 1000, TTF_{invert} = 2.8, TTF_{fish} = 1.1) were used in calculations as follows:

Model 1=Trophic level 3 (TL-3) fish eating invertebrates

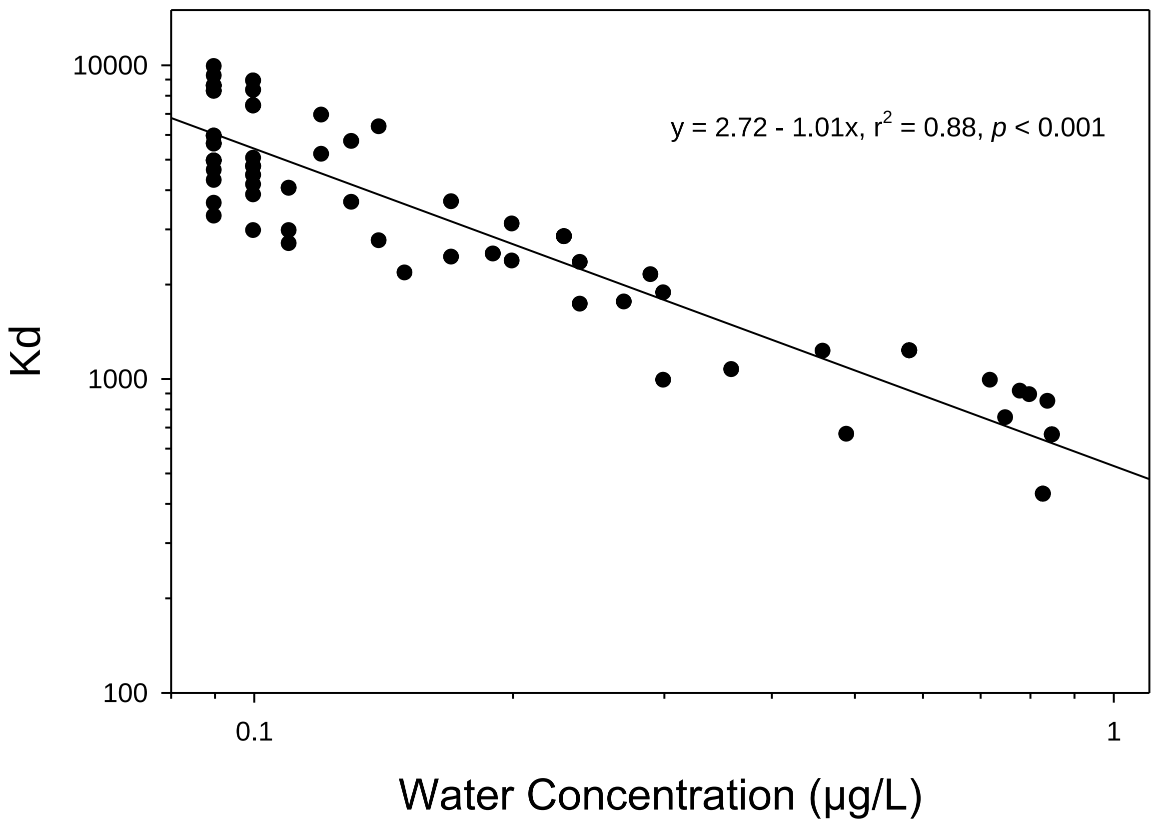
Model 2= TL-4 fish eating TL-3 fish

Model 3=Model 2 with K_d estimated using all years regression (log Kd = 2.72-1.01(logDSM2))

Model 4=Model 2 with K_d estimated using normal/wet years (2000/2005) regression (log Kd = 2.71-0.95(logDSM2))

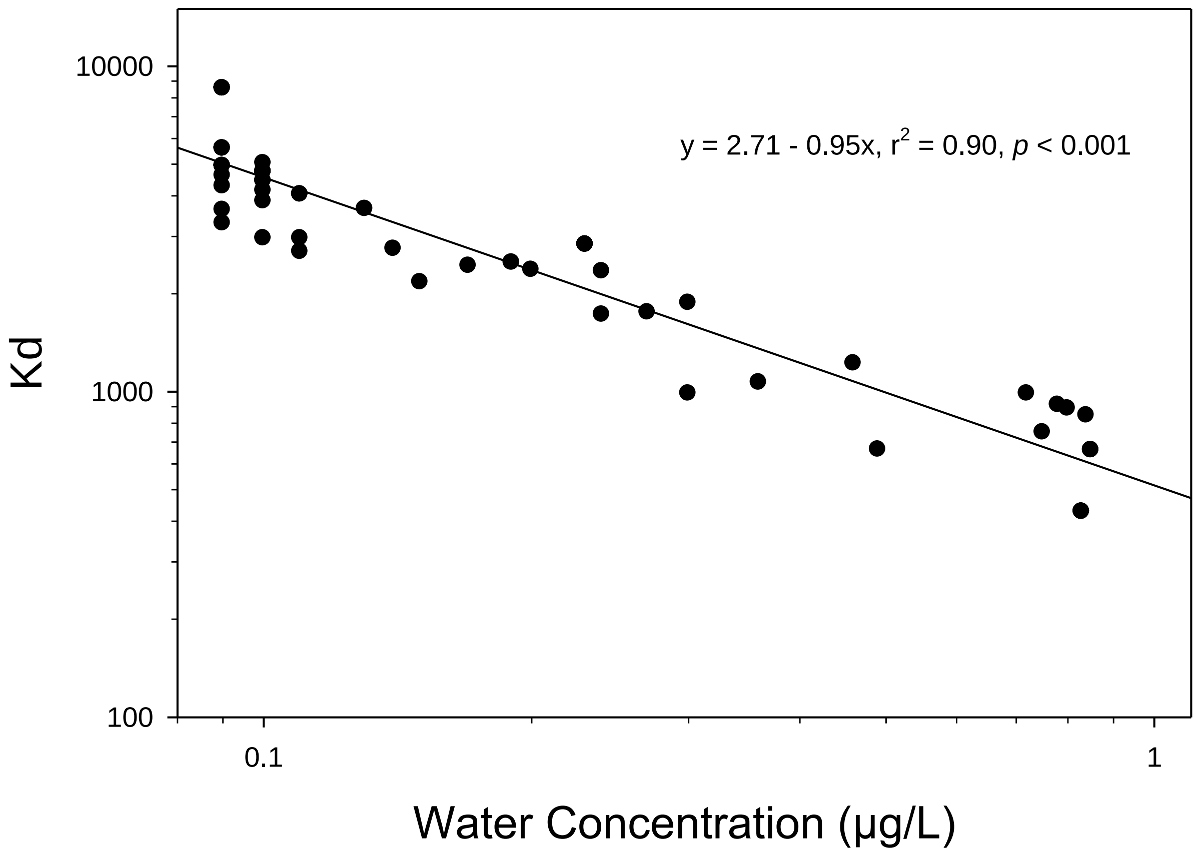
Model 5=Model 2 with K_d estimated using dry years (2007) regression (logKd = 2.84-1.02(logDSM2))

Attachment Figure 5.F-2. Log-log Regression Relation of Estimated K_d to Waterborne Selenium Concentration for Model 3 in All Years (Based on Years 2000, 2005, and 2007)



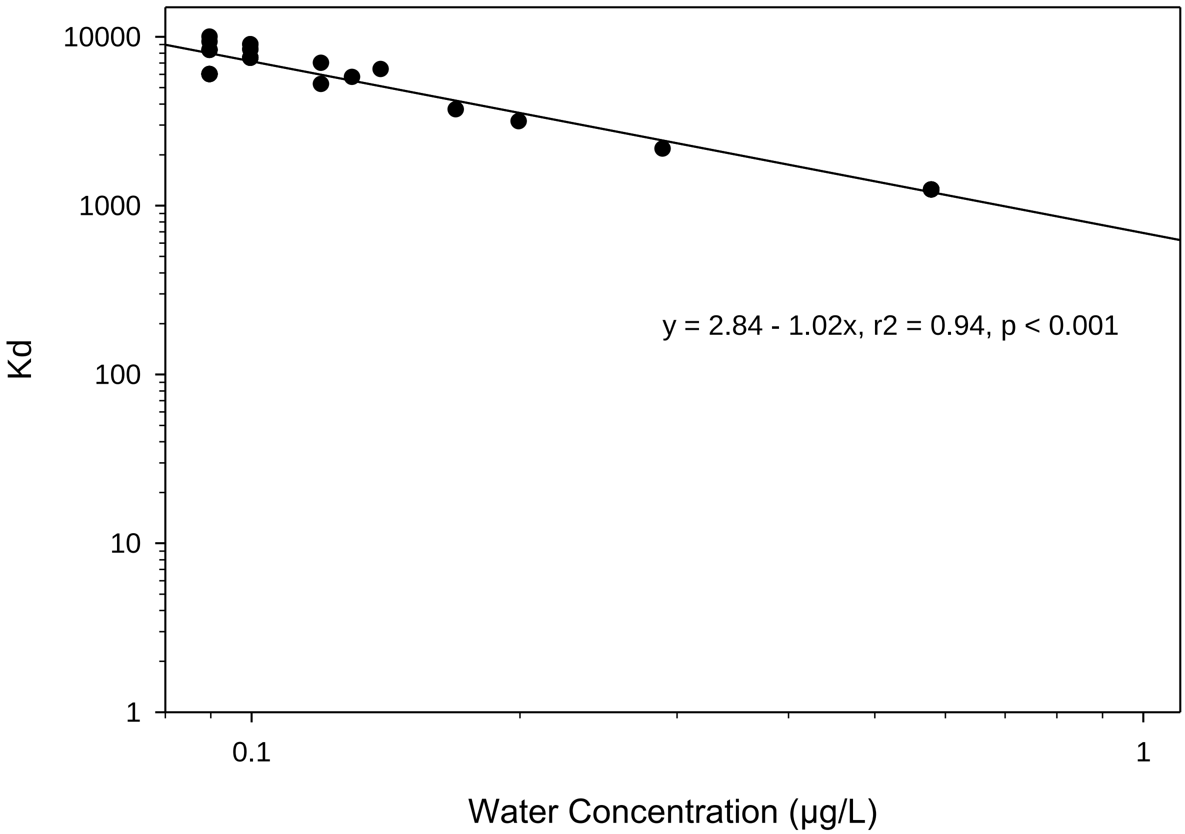
To predict the K_d (y) from water concentrations using the regression equation, take the log of the water concentration (x), multiply it by the slope (-1.01), which gives a positive number for x<1 (i.e., waterborne selenium concentrations less than 1 µg/L); then add this number to the intercept (2.72) and take the antilog.

Attachment Figure 5.F-3. Log-log Regression Relation of Estimated K_d to Waterborne Selenium Concentration for Model 4 in Normal/Wet Years (Based on Years 2000 and 2005)



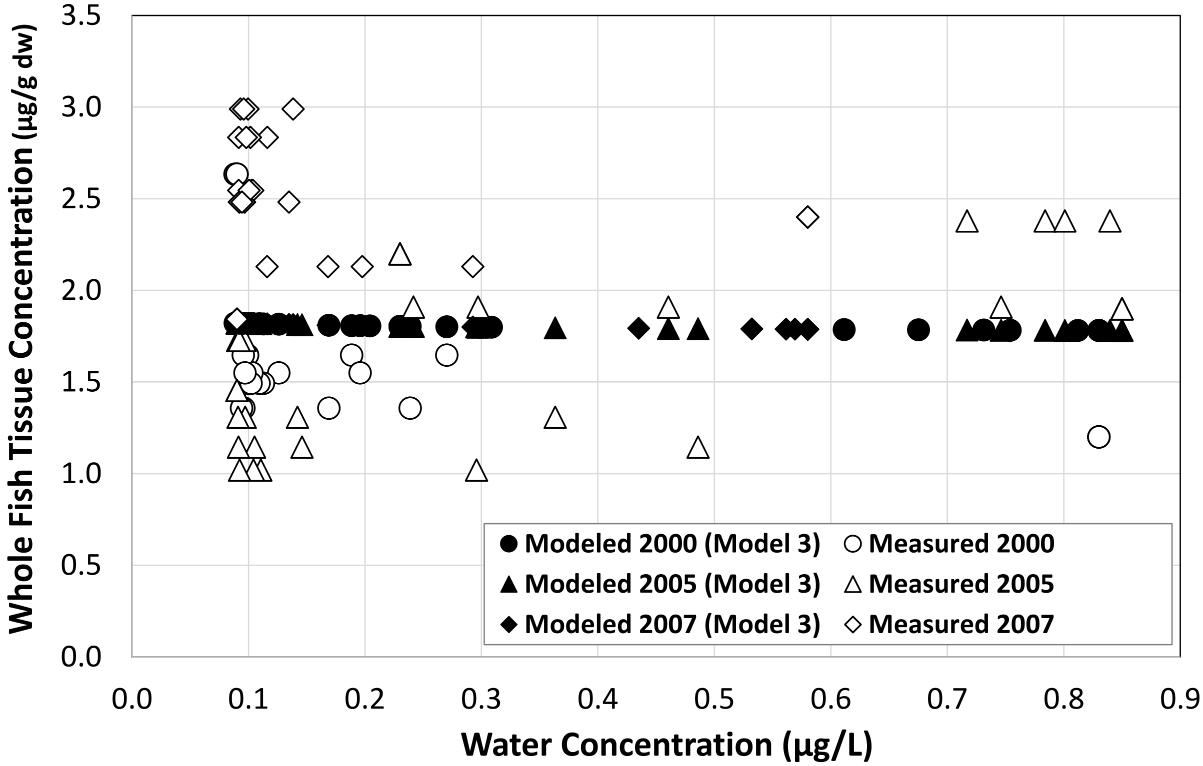
To predict the K_d (y) from water concentrations using the regression equation, take the log of the water concentration (x), multiply it by the slope (-0.95), which gives a positive number for x<1 (i.e., waterborne selenium concentrations less than 1 µg/L); then add this number to the intercept (2.71) and take the antilog.

Attachment Figure 5.F-4. Log-log Regression Relation of Estimated K_d to Waterborne Selenium Concentration for Model 5 in Dry Years (Based on Year 2007)



To predict the K_d (y) from water concentrations using the regression equation, take the log of the water concentration (x), multiply it by the slope (-1.02), which gives a positive number for x<1 (i.e., waterborne selenium concentrations less than 1 µg/L); then add this number to the intercept (2.84) and take the antilog.

Attachment Figure 5.F-5. Distribution of Data for Selenium Concentrations in Largemouth Bass Relative to Waterborne Selenium for Model 3



Attachment Figure 5.F-6. Distribution of Data for Selenium Concentrations in Largemouth Bass Relative to Waterborne Selenium for Model 4 and Model 5