Ecosystem-Scale Selenium Modeling in Support of Fish and Wildlife Criteria Development for the San Francisco Bay-Delta Estuary, California

Administrative Report

Tables 1 through 22

U.S. Department of the Interior
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Find the full report and other attachments at http://www.epa.gov/region9/water/ctr

Table 1. Oil refinery Se loads discharged to the Bay-Delta during 1986-2009. [San Francisco Bay Board, 1992a,b; 1993; Lila Tang and Johnson Lam, San Francisco Bay Board, personal communication, 1999-2006; USEPA, 2010].

year	Chevron Refinery (Richmond, CA; discharge to San Pablo Bay) lbs Se/year	Martinez (Shell) Refinery (Martinez, CA; discharge to Carquinez Strait) lbs Se/year	Tosco (Conoco Phillips) Refinery (Rodeo, CA; discharge to San Pablo Bay) lbs Se/year	Tesoro Golden Eagle Refinery (Martinez, CA; discharge to Suisun Bay) lbs Se/year	Valero Refinery (Benicia, CA; discharge to Suisun Bay) lbs Se/year	refinery total lbs Se/year	proposed permitted load[d] lbs Se/yr
1986	-	-	-	-	-	5783	-
1987	-	-	-	-	-	4419	-
1988	-	-	-	-	-	4417	-
1989	-	-	-	-	-	3953	-
1990	-	-	-	-	-	5222	-
1991	-	-	-	-	-	5634	-
1992	-	-	-	-	-	5592	-
1993	-	-	-	-	-	-	2666
1994	-	-	-	-	-	-	2222
1995	-	-	-	-	-	-	1727
1996	-	-	-	-	-	-	1234
1997	-	-	-	-	-	-	1234
1998	-	-	-	-	-	-	1234
1999	314	441	107	129	133	1124	1234
2000	174	368	114	130	126	912	1234
2001	282	451	123	100	144	1100	1234
2002	197	455	145	145	153	1095	1234
2003	239	464	90	144	175	1112	1234
2004	204	472	115	149	159	1099	1234
2005	276	490	154	154	177	1251	1234
2006	278	542	159	193	195	1367	1234
2007[a]	-	-	-	-	-	-	1234
2008	221	709	187	193[b]	160	1470[c]	1234
2009	210	515	209	193[b]	160	1287[c]	1234

[a]Data not available from USEPA (2010); [b]Data not available from USEPA (2010), therefore estimated as 2006 Se load ; [c]Includes estimated Se load for Tesoro Refinery; [d]baseline for reductions defined as 1989-1991 average annual loading of 4,935 lbs Se/year.

Table 2. Generalized steps in ecosystem-scale methodology for translation of a tissue Se concentration to a water-column Se concentration for protection of fish and aquatic-dependent wildlife. [Adapted from Table 5, Presser and Luoma, 2010.]

Translation of Tissue Criterion to Water-Column Concentration

• Develop a conceptual model of food webs in watershed.
• Choose toxicity guideline for fish or aquatic bird species in estuary.
• Choose fish or bird species to be protected in watershed.
• For fish, choose species-specific TTF_{fish} or use default TTF_{fish} of 1.1; for birds, choose species-specific TTF_{ibird} or use default TTF_{bird} of 2.0.
• Identify appropriate food web(s) for selected fish or bird species based on species-specific diet.
• Choose site-specific $TTF_{invertebrate}$ for invertebrates in selected food web(s) or use default $TTF_{invertebrate}$ for species of invertebrate (see list in Presser and Luoma, 2010).
• Choose site-specific K_d or use K_d indicative of a) generalized source of Se and receiving water conditions or b) site-specific hydrologic type and speciation; or a default K_d of 1000 (see list in Presser and Luoma, 2010).
• Solve equation(s) for allowable water-column concentration for protection of fish or birds (i.e., predator)
If assume single invertebrate diet, then
o $C_{water} = (C_{predator}) \div (TTF_{predator})\ K_d\ (TTF_{invertebrate})$
If assume a mixed diet of invertebrates, then
o $C_{water} = (C_{predator}) \div (TTF_{predator})\ (K_d)\ [(TTF_{invertebrate\ a})\ (\text{prey fraction})] + [(TTF_{invertebrate\ b})\ (\text{prey fraction})] + [(TTF_{invertebrate\ c})\ (\text{prey fraction})]$
If assume sequential bioaccumulation in longer food webs, then
o $C_{water} = (C_{predator}) \div (TTF_{predator})\ K_d\ (TTF_{invertebrate\ a})\ (TTF_{forage\ fish})$
o $C_{water} = (C_{predator}) \div (TTF_{predator})\ K_d\ (TTF_{TL2\ invertebrate})\ (TTF_{TL3\ invertebrate})\ (TTF_{TF3\ fish})$
where TL = trophic level

Table 3. List of species considered for evaluation of Se exposure risk in the San Francisco Bay/Delta. [Reproduced from USFWS, 2008, Table 1. Updates, personal communication, S. Detwiler, USFWS, Sacramento, California, 11/17/10).

Common Name	Scientific Name	Federal Status	California State Status	Potential to be adversely affected by selenium in Bay/Delta*
Mammals				
salt marsh harvest mouse	*Reithrodontomys raviventris*	endangered	protected	As a terrestrial herbivorous mammal, unlikely to be among the most exposed and sensitive of wildlife species; therefore not likely to be a "species most at risk."
Birds				
American white pelican	*Pelecanus erythrorhynchos*	MBTA	concern	SF Bay is North end of West Coast distribution of non-breeders. Preys on some bottom-feeding fish as well as schooling fish, but not likely to be a "species most at risk.".
California brown pelican	*Pelecanus occidentalis californicus*	endangered (delisted 11/2009, MBTA)	protected, endangered (protected 2/09)	SF Bay is North end of W Coast distribution. Feeds mainly on surface-schooling fish; therefore, not part of benthic-based food chain and not likely to be a "species most at risk."
white-faced ibis	*Plegadis chihi*	concern	concern	Breeds and winters in San Joaquin Valley. Inhabits mainly freshwater wetlands, but also estuarine wetlands. Eats aquatic and moist soil invertebrates. At some risk but not likely to be a "species most at risk."
double-crested cormorant	*Phalacrocorax auritus*	MBTA	concern	Winters in Central Valley and SF Bay/Delta. Feeds on bottom-dwelling fish and invertebrates as well as schooling fish. At some risk but not likely to be a "species most at risk."
American bittern	*Botaurus lentiginosus*	concern	none	Feeds mainly in freshwater marshes, eating mainly insects and small vertebrates; therefore not likely to be a "species most at risk."
western least bittern	*Ixobrychus exilis hesperis*	concern	concern	Breeds in SF Delta. Feeds in fresh and brackish water marshes, eating mainly small fish and insects; therefore not likely to be a "species most at risk.".
Aleutian Canada goose	*Branta canadensis leucopareia*	delisted, MBTA	none	Winters in California, feeding primarily in upland crops and fallow fields. Sensitive to selenium but unlikely to be exposed in estuary; therefore not likely to be a "species most at risk."
greater scaup	*Aythya marila*	MBTA	none	SF Bay is one of 2 major wintering areas on W coast of N America. Feeds on benthic mollusks that efficiently bioaccumulate selenium in the SF Bay/estuary, therefore likely to be a "species most at risk."
lesser scaup	*Aythya affinis*	MBTA	none	SF Bay is an important wintering area; feeds on clams; therefore likely to be a "species most at risk."
black scoter	*Melanitta nigra*	MBTA	none	Winters along California coast, diving mainly for mollusks; therefore likely to be a "species most at risk."
white-winged scoter	*Melanitta fusca*	MBTA	none	Winters along California coast and estuaries, diving mainly for mollusks; therefore likely to be a "species most at risk."
surf scoter	*Melanitta perspicillata*	MBTA	none	Winters along California coast, diving mainly for mollusks; therefore likely to be a "species most at risk."
osprey	*Pandion haliaetus*	MBTA	concern	High trophic level piscivore; not at risk overall and exposure well represented by bald eagle. Therefore not treated here as a "species most at risk."
bald eagle	*Haliaeetus leucocephalus*	delisted, MBTA,BGEPA	protected, endangered	High trophic level piscivore; at risk overall and exposed to aquatic food chain in the SF Bay/Delta; therefore likely to be a "species most at risk."

Common Name	Scientific Name	Federal Status	California State Status	Potential to be adversely affected by selenium in Bay/Delta*
northern harrier	*Circus cyaneus*	MBTA	concern	High trophic level but less exposed to aquatic food chain than bald eagle; therefore not likely to be a "species most at risk."
white-tailed kite	*Elanus leucurus*	concern	protected	Feeds mainly on terrestrial mammals; minimal exposure to aquatic selenium; therefore not likely to be a "species most at risk."
American peregrine falcon	*Falco peregrinus anatum*	delisted, MBTA	protected, concern	Delisted but monitored for population status and contaminants. Exposed to selenium in aquatic food chain as predator on piscivorous birds, but exposure generally diluted by terrestrial component of diet; therefore not likely to be a "species most at risk."
prairie falcon	*Falco mexicanus*	MBTA	concern	Winters along California coast; high trophic level but in mainly terrestrial food chain; therefore not likely to be a "species most at risk."
California black rail	*Laterallus jamaicensis coturniculus*	MBTA	protected, concern	Inhabits tidal marsh in SF Bay estuary. Feeds on invertebrates, including snails, but also seeds; therefore not likely to be a "species most at risk."
California clapper rail	*Rallus longirostris obsoletus*	endangered	protected, endangered	Subspecies endangered and endemic to SF estuary; feeds on benthic invertebrates, including filter-feeders that bioaccumulate selenium; therefore likely to be a "species most at risk."
marbled murrelet	*Brachyramphus marmoratus*	threatened	endangered	Forages in bays along Pacific coast in summer, but not recorded in SF Bay/Delta. Dives for pelagic food: schooling fish and euphausiids (krill). Therefore not likely to be a "species most at risk."
California least tern	*Sterna antillarum browni*	endangered	protected, endangered	Breeds primarily in Central San Francisco Bay but can nest throughout estuary. Feeds throughout estuary, mainly on surface fish, not part of the benthic mollusk-based food chain; therefore not likely to be a "species most at risk."
black tern	*Chlidonias niger*	concern	concern	Breeds in C Valley including SF Delta. Feeds on marine and freshwater surface fish and insects; therefore not likely to be a "species most at risk."
Caspian tern	*Sterna caspia*	MBTA	none	Preys heavily on juvenile salmonids, but not endangered overall; therefore not likely to be a "species most at risk."
western snowy plover	*Charadrius alexandrines*	threatened	concern	Terrestrial component of diet likely provides dietary dilution of aquatic system selenium exposures; have been shown to be very tolerant of selenium exposure; therefore not likely to be a "species most at risk."
mountain plover	*Charadrius montanus*	concern	concern	Winters in agricultural fields of Sacramento/San Joaquin Valley. Diet mainly terrestrial; therefore not likely to be a "species most at risk."
tricolored blackbird	*Agelaius tricolor*	concern	concern	Nests colonially, mainly in freshwater marshes. Feeds on terrestrial as well as freshwater insects; therefore not likely to be a "species most at risk."
Reptiles				
giant garter snake	*Thamnophis gigas*	threatened	threatened	Aquatic predator, but not known to inhabit the estuary; therefore not likely to be a "species most at risk" in the estuary.
Fish				
Chinook salmon	*Oncorhynchus tshawytscha*	endangered/ threatened	endangered/ threatened	Sensitive to selenium; most sensitive life stages occur in rivers and estuary; therefore likely to be a "species most at risk."
steelhead	*Oncorhynchus mykiss*	threatened	none (in Central Valley)	Sensitive to selenium; most sensitive life stages occur in rivers and estuary; therefore likely to be a "species most at risk."
delta smelt	*Hypomesus transpacificus*	threatened	threatened	Endemic to the Bay/Delta estuary. Feeds on zooplankton, not a pathway of greatest exposure, but threatened overall, so included as a "species most at risk."

Common Name	Scientific Name	Federal Status	California State Status	Potential to be adversely affected by selenium in Bay/Delta*
longfin smelt	*Spirinchus thaleichthys*	concern	endangered	SF Bay/estuary is S end of distribution. Prefers more saline water than delta smelt. Overall less threatened and probably less exposed than delta smelt so adequately represented by that species. Therefore not treated here as a "species most at risk."
green sturgeon	*Acipenser medirostris*	threatened	concern; fishing prohibited	Threatened overall, and vulnerable to selenium as a clam-eating bottom feeder in the SF estuary; therefore likely to be a "species most at risk." Emergency regulations issued by CDFG March 2006--Zero (0) bag limit for green sturgeon year-round in all areas.
white sturgeon	*Acipenser transmontanus*	none	limited fishing	Population in the SF estuary not federally listed, but vulnerable to selenium as a clam-eating bottom feeder. Therefore, treated here as a "species most at risk." The daily bag and possession limit established by CDFG is one fish that must be between 46 inches and 72 inches total length. The yearly limit is three.
river lamprey	*Lampetra ayresi*	none	watch list	Anadromous; feeds on young salmon. Recorded from lower Sacramento and San Joaquin Rivers. Not federally listed; therefore not considered to be a "species most at risk."
Sacramento perch	*Archoplites interruptus*	concern	concern	Fry feed primarily on bottom-dwelling crustaceans, insect larvae, snails, and fish. One captured in the Delta in 1992, not likely to represent an established population there. Therefore not considered to be a "species most at risk" in the Delta. Update: However, plans for possible future reintroduction of this species in the Delta should take into account possible risk to individuals of a recovering population segment (pers. comm.., Victoria Poage, Delta Native Fishes Recovery Coordinator, Bay Delta Fish and Wildlife Office, USFWS.
Sacramento splittail	*Pogonichthys macrolepidotus*	concern	threatened	Vulnerable to selenium as clam-eating bottom feeder in the SF estuary; therefore likely to be a "species most at risk."
striped bass	*Morone saxatilis*	none	none	Introduced sport fish in California. Population in Delta declined sharply in early 2000s, but species overall not threatened. Therefore not considered to be a "species most at risk."
threadfin shad	*Dorosoma pretenense*	none	none	Introduced in California as food for game fish. Population in Delta declined sharply in early 2000s, but species overall not threatened. Therefore not considered to be a "species most at risk."
tidewater goby	*Eucyclogobius newberryi*	endangered	endangered	Bottom-dwelling carnivore. Prefers semi-closed estuaries. Potentially exposed, but not found recently (since 1984) in the Bay area; therefore not considered to be a "species most at risk" in the SF Bay/Delta.
California halibut	*Paralichthys californicus*	none	none	Bottom dweller inhabiting the SF Bay, but overall not threatened; therefore not likely to be a "species most at risk."
leopard shark	*Triakis semifasciata*	none	none	Bottom dweller inhabiting the SF Bay, but overall not threatened; therefore not likely to be a "species most at risk."
starry flounder	*Platichthys stellatus*	none	none	Bottom dweller inhabiting the SF Bay. Population in bay declined sharply since 1980, but overall not threatened; therefore not likely to be a "species most at risk."
Invertebrates				
Dungeness crab	*Cancer magister*	none	none	Estuary is nursery for this ocean-breeding bottom feeder, but overall not threatened; therefore not likely to be a "species most at risk."

Federal Status: Endangered: listed as endangered under the Federal Endangered Species Act; Threatened: listed as threatened under the Federal Endangered Species Act; Proposed threatened: proposed as threatened under the Federal Endangered Species Act; Concern: designated a species of concern; Delisted: removed from the list of endangered and threatened species under the Federal ESA; MBTA: protected under Migratory Bird Treaty Act; BGEPA protected under the Bald and Golden Eagle Protection Act.
California State Status: Endangered: listed as endangered under the California Endangered Species Act; Threatened: listed as threatened under the California Endangered Species Act; Concern: designated by the California Department of Fish and Game as a species of concern; Protected: Fully protected under the Fish and Game Code of California predating the California Endangered Species Act
* Assessment based upon population status, dependence upon benthic food web, and sensitivity to selenium. Aquatic dependent species feeding directly in the benthic food web of the San Francisco Estuary were considered to be at greater risk to selenium exposure than those species feeding in a pelagic/planktonic food web. This assumption is based upon the work of Stewart et al. (2004).

Table 4. Species most at risk from Se exposure in the San Francisco Estuary: summary data. [Reproduced from USFWS, 2008 Table 2].

Common Name	Scientific Name	Probable critical life stage for Se effects[1]	Food ingestion rate at critical life stage (g ww/day) [2]	Food ingestion rate at critical life stage (g dw/kg body weight/day) [3]	Body weight at critical life stage (g) [4]	Diet	Mainly clam-based food chain?[5]	Percent of diet that is clam-based (worst case)
bald eagle	*Haliaeetus leucocephalus*	Adult female (egg laying)	644	249	5275 (female)	fish, birds, mammals	no	22.8[6]
California clapper rail	*Rallus longirostris obsoletus*	Adult female (egg laying)	172	46.8	346	mussels, spiders, clams, crabs, snails, marsh cordgrass seeds	yes	64.1
greater scaup	*Aythya marila*	Adult male and female (migration)	313	85.8	1054 (male)	clams, snails, other mollusks, crustaceans, algae	yes	80.7
lesser scaup	*Aythya affinis*	Adult male and female (migration)	246	67.5	734 (male)	clams, other mollusks, aquatic insects, crustaceans, plants	yes	96
white-winged scoter	*Melanitta fusca*	Adult male and female (migration)	465	127.3	1917 (male)	clams, other mollusks, crustaceans, aquatic insects	yes	75[7]
surf scoter	*Melanitta perspicillata*	Adult male and female (migration)	314	86.0	1059 (male)	mussels, other mollusks, plants, crustaceans	yes	86[8]
black scoter	*Melanitta nigra*	Adult male and female (migration)	325	89.1	1117 (male)	mussels, clams, snails, barnacles	yes	80[9]
Chinook salmon	*Oncorhynchus tshawytscha*	Migrating/rearing juvenile		23.3	0.5-18	insects, crustacea, juvenile fish	no	0[10]
steelhead	*Oncorhynchus mykiss*	Migrating/rearing juvenile		19.9	31-105	insects, annelids, *Daphnia*	no	0[10]
green sturgeon	*Acipenser medirostris*	Juvenile or adult female		20	1300 (average caught)	benthic crustacea, mollusks and fish	probably substantially	See white sturgeon
white sturgeon	*Acipenser transmontanus*	Juvenile or adult female		15-20	6280 (mode)	benthic mollusks and crustacea	substantially	41.1[11]
delta smelt	*Hypomesus transpacificus*	Juvenile or adult female		114	0.32 (average Jun-Aug)	copepods, cladocerans, amphipods, insect larvae	no	0
Sacramento splittail	*Pogonichthys macrolepidotus*	Juvenile or adult female		33.7	121 (mode)	benthic detritus, clams, other mollusks, mysids	substantially	34

1. For most species it is premature and speculative to designate a critical life stage at this time. Such designation prejudges the outcome of a thorough search of the toxicology literature.
2. Food ingestion rates based on wet weight can be calculated from available parameters (Nagy 2001) for birds, mammals, reptiles and amphibians, but not, in general for fish. [Note: food ingestion rate for fish are available elsewhere (e.g., Baines et al., 2002); see text for further discussion].
3. For birds, the food ingestion rate as dry weight is calculated from the regression parameters for dry matter intake per day from Table 3 in Nagy (2001), using categories of birds used to calculate food ingestion rate in terms of wet weight as described in the text below.
4. See note 1 above. For anadromous species, a range of body weights is given corresponding to the period spent rearing in the estuary.
5. We interpret "clam-based" broadly to mean filter-feeding benthic mollusk-based.
6. For the worst case, we assume that all birds consumed are those waterfowl (scaups and scoters) that primarily feed on benthic mollusks (clams, etc.).

7. Percent of mollusks in gizzards of 819 adults and 4 juveniles collected in coastal Maine and Washington (Cottam C. *U.S. Dep. Agric. Tech. Bull.* 643).
8. Wet weight percents of summer and winter gizzard contents, British Columbia salt water (Vermeer K. 1981 *Wildfowl* 32:107-116; Vermeer and Bourne 1984 as summarized in Appendix 1 of Savard *et al*. 1998).
9. Percent mussels, winter, coastal New England (reviewed in Bordage and Savard 1995).
10. Although the diets of salmon, steelhead and delta smelt are not known to be clam-based, these species may still be at risk from selenium because of greater sensitivity to selenium. The sensitivity of salmon and steelhead is documented below. The sensitivity of delta smelt to selenium is unknown; population numbers are alarmingly low, so this species is particularly vulnerable to any adverse effect.
11. Percentage clams by volume, fall, Suisun Bay and Carquinez Strait (Table 10 below).

Table 5. Selenium effect levels derived for protection of species at risk in the San Francisco Estuary. [Reproduced from USFWS, 2009b, Table 1).

	Concentration of selenium (µg/g dry wt.) corresponding to effect level:										
	Se in diet			Se in target species (whole body or egg)							
Species	0%	5%	10%	0%	5%	10%	Effect	Exposure duration (days)	Form of selenium	Model	Data source
Mallard	2.30	4.36	5.29	2.77	5.86	7.73	hatchability	>40 (parental)	seleno-DL-methionine	Beckon *et al*. 2008	Heinz *et al*. 1989
White sturgeon				na	7.03	8.13	larval edema and skeletal defects	up to 6 months	selenized yeast	log-logistic	Linville 2006
adult[a]	na	25.5	32.5				assimilation	6 months	selenized yeast	power	Linville 2006
juvenile[a]	na	0.95	1.57				assimilation	56	seleno-L-methionine	power	Tashjian *et al* 2006
Chinook salmon	1.54	2.25	2.67	1.01	1.53	1.84	mortality	90	assimilated or seleno-DL-methionine	Brain and Cousens 1989	Hamilton et al. 1990
Rainbow trout	2.41	4.22	5.04	1.27	1.89	2.19	reduction in growth	140	sodium selenite	Beckon *et al*. 2008	Hilton *et al*. 1980
	0.31	1.01	1.56				assimilation	90	seleno-L-methionine	power	Vidal *et al*. 2005

[a] Adult and juvenile white sturgeon effect guidelines are being revised; [b] Revision, personal communication, USFWS, William Beckon, 10/27/10: EC05 = 3.8; EC10 = 8.2.

Table 6. Generic selenium effect levels for fish and birds.

	Se (µg/g dw)	Se (µg/g dw)	Se (µg/g dw)
bird (egg)	5.5 (NEC) (Skorupa, 2008)	7.7 (EC10) (USFWS, 2009b; Skorupa, 2008)	12 (>EC20)
fish (wb)	-	5.0 (EC10) (USFWS, 2005; Skorupa et al., 2004)	8.0 (EC40)
diet (fish and birds)	3.6	<4.9 (Skorupa et al., 2004)	5.7

Table 7. Available data for the Bay-Delta including transects and biota studies. [Water year classification based on precipitation in the Sacramento Valley. A high flow season is defined from December through May; a low flow season is defined as June through November.]

study date	water year/flow season	residence time (days)/ salinity at Golden Gate Bridge (psu)	reference	Se data
Northern Reach from Sacramento/ San Joaquin Rivers to Golden Gate Bridge				
April 1986	wet/high	9.8/--	Cutter 1989; Meseck, 2002	dissolved; dissolved speciation; particulate
September 1986	wet/low	24.4/-	Cutter 1989; Meseck, 2002	dissolved; dissolved speciation; particulate
October 1987	critical/low	73.5/-	Cutter and San Diego-McGlone, 1990	dissolved; dissolved speciation
December 1987	critical/high	8.0/-	Cutter and San Diego-McGlone, 1990	dissolved; dissolved speciation
March 1988	critical/high	35.5/-	Cutter and San Diego-McGlone, 1990	dissolved; dissolved speciation
May 1988	critical/high	25/-	Cutter and San Diego-McGlone, 1990	dissolved; dissolved speciation
1989-1990	critical	-	Urquhart and Regalado, 1991; Kroll and Doroshov, 1991	white sturgeon: flesh; ovary; egg yolk components; plasma
1986-1990	wet 1986; dry 1987; 1988 critical; 1989 dry; 1990 critical	-	White et al., 1987, 1988, 1989; Urquhart and Regalado, 1991	surf scoter, greater and lesser scaup liver and flesh: Suisun and San Pablo Bays
1975, 1986, 1987	wet 1975; wet 1986; dry, 1987	-	Lonzarich et al., 1992	California clapper rail eggs from the northern and southern reaches of Bay
1982; 1985	wet 1982; dry 1985	-	Ohlendorf et al., 1986; 1991	surf scoter, greater scaup liver (southern and northern Bay)
December 1986-1987 (early winter); March 1986-1987(late winter)	wet 1986; dry 1987	-	Takekawa et al., 2002	canvasbacks (n = 29), greater scaup, lesser scaup (n =30) liver and kidney from North, Central, and South Bays
1989	dry	-	Hoffman et al., 1998	surf scoter, greater scaup, ruddy duck liver (Suisun Bay; Tomales Bay)
1985-1986	dry 1985; wet 1986	-	White et al., 1987, 1988, 1989; Urquhart and Regalado, 1991; Johns et al., 1988	sediment and clam
1991, 1992, 1998, 1999 breeding seasons	critical 1991, 1992; wet 1998, 1999	-	Schwarzbach et al., 2006	California clapper rail egg from six tidal marshes in northern and southern reaches of Bay
1994, 1995, 1997, 1999, 2000, 2001	critical 1994; wet 1995-1999; above normal 2000; dry 2001	-	CH2M HILL, 1994; 1995; 1998; 2000; 2001; 2002; Ohlendorf and Gala, 2000; Skorupa, 1998	shorebird eggs from Chevron Richmond Refinery Water Enhancement Wetland
November 1997	wet/low	68/32.5	Cutter and Cutter, 2004; Meseck, 2002; Doblin et al., 2006	Bay-Delta transects: dissolved; dissolved speciation; particulate; particulate speciation
June 1998	wet (El Niño) /high	11/24.8	Cutter and Cutter, 2004; Doblin et al., 2006	Bay-Delta transects: dissolved; dissolved speciation, particulate; particulate speciation
October 1998	wet/low	22/30.2	Cutter and Cutter, 2004; Doblin et al., 2006	Bay-Delta transects: dissolved; dissolved speciation, particulate; particulate speciation

study date	water year/flow season	residence time (days)/ salinity at Golden Gate Bridge (psu)	reference	Se data
April 1999	wet/high	16/28.5	Cutter and Cutter, 2004; Doblin et al., 2006	Bay-Delta transects: dissolved; dissolved speciation, particulate; particulate speciation
November 1999	above normal/ low	70/32.2	Cutter and Cutter, 2004; Doblin et al., 2006	Bay-Delta transects: dissolved; dissolved speciation,particulate; particulate speciation
Nov 97, Jun 98, Oct 98, Nov 99	see above for Cutter and Cutter, 2004	-	Meseck, 2002	sedimentary Se and speciation; pore-water Se: San Pablo Bay: Suisun Bay, Delta, mudflat marsh near Martinez
1995-1997	all wet years	-	Linville et al., 2002 (see Presser and Luoma, 2006, Fig 15)	clams from 21 locations
1997-2000	1997-1999 wet; 2000 above normal	-	Greenfield et al., 2005	sport fish at 6 locations including San Pablo Bay
1999-2000	1999 wet; 2000 above normal	-	Stewart et al., 2004	fall and early winter food webs
1998-1999	wet 1998-1999	-	Purkerson et al., 2003	zooplankton from stations in northern, central and southern reaches of Bay
March to July, 2000; 2001	above normal 2000; dry 2001	-	Schwarzbach and Adelsbach, 2003	aquatic bird eggs including California clapper rail eggs from San Francisco Bay, Suisun Bay, and the Delta
March, 2002	dry	-	Hunt et al., 2003	surf scoter and greater scaup muscle: Suisun and San Pablo Bays:
May, 1995-February, 2010		-	Kleckner et al., 2010	USGS clam database: monthly *C. amurensis*: at seven USGS stations
2004-2006 winter	below normal 2004; above normal 2005; wet 2006	-	Wainwright-De La Cruz, et al., 2008	surf scoter liver :San Pablo, Suisun, and Central Bays
Mar-Apr, 2005	above normal	-	Ackerman and Eagles-Smith, 2009	avocet, stilt, tern liver: north and south Bay, prebreeding season
2003-2005	above normal 2003; 2005; below normal 2004	-	Linares-Casenave et al., 2010	white sturgeon tissues (muscle, gonad, kidney, liver): six locations from Chipps Island to San Pablo Bay
Rio Vista and Stockton to Benicia/Carquinez Strait				
October 7-8,1998	wet/low	-	Personal communication M. Doblin, March 2009	sediment cores from six Delta locations
July 12-13, 2000	above normal/low	-	Lucas and Stewart, 2007	dissolved; dissolved speciation; particulate
January 22, 2003	above normal/high	-	Lucas and Stewart, 2007	dissolved; dissolved speciation; particulate
April 22-23, 2003	above normal/high	-	Lucas and Stewart, 2007	dissolved; dissolved speciation; particulate
June 17, 2003	above normal	-	Lucas and Stewart, 2007	dissolved; dissolved speciation; particulate
October 10, 2003	below normal/low	-	Lucas and Stewart, 2007	dissolved; dissolved speciation; particulate
January 15, 2004	below normal/high	-	Lucas and Stewart, 2007	dissolved; dissolved speciation; particulate
2002	dry	-	Lucas and Stewart, 2007	sediment cores from three Delta locations

Table 8. Bay-Delta hydrologic conditions, Net Delta Outflow Index, salinity, observed dissolved Se concentrations, observed suspended particulate material Se concentrations, and calculated K_ds. [Arranged by increasing residence time of transect, except for November, 1997. See text for additional discussion.]

hydrologic condition (transect, residence time, water year/flow season)	Net Delta Outflow Index daily average per month (cfs)	salinity mean and range (psu)	observed dissolved Se mean and range (µg/L)	observed particulate Se mean and range (µg/g dw)	calculated K_d mean and range[a]
June 16-17, 1998 11 day residence; wet/high	73,732	5.8 (0.01-24.5)	0.181 (0.101-0.303)	0.518 (0.150-1.59)	3,198 (712-11,054)
April 13-14, 1999 16 day residence; wet/high	35,034	11.4 (0-28.9)	0.116 (0.076-0.165)	0.636 (0.190-1.41)	5,824 (1,151-13,317)
October 7-8, 1998 22 day residence; wet/low	12,251	14.6 (0-30.1)	0.120 (0.077-0.164)	0.713 (0.289-2.21)	6,501 (2,202-26,912)
November 4-5, 1999 70 day residence; above normal/low	6,951	15.0 (0-32.2)	0.102 (0.070-0.137)	0.746 (0.428-1.66)	7,614 (3,496-19,785)
November 5-6, 1997 68 day residence; wet/low	9,632	17.2 (0.56-32.0)	0.192 (0.101-0.320)	0.842 (0.470-1.58)	4,652 (2,333-8,349)

[a] K_d grand mean for 1998-1999 transects = 5,784

Table 9. Suisun Bay-Carquinez Strait hydrologic conditions, Net Delta Outflow Index, salinity, observed dissolved Se concentrations, observed suspended particulate material Se concentrations, and calculated K_ds. [Arranged by increasing residence time of transect, except for November, 1997. See text for additional discussion. See Doblin et al., 2006 and Figure 14 for division into subset.]

hydrologic condition (transect, residence time, water year/flow season)	Net Delta Outflow Index (daily average per month cfs)	salinity mean and range (psu)	observed dissolved Se mean and range (µg/L)	observed particulate Se (mean and range) µg/g dw	calculated K_d mean and range[a]
June 16-17, 1998 11 day residence; wet/high	73,732	0.76 (0.44-1.08)	0.213 (0.211--0.215)	0.252 (0.150-0.354)	1,180 (712-1,647)
April 13-14, 1999 16 day residence; wet/high	35,034	5.82 (4.9-7.3)	0.118 (0.076-0.154)	0.303 (0.240-0.350)	2,666 (2,274-3,168)
October 7-8, 1998 22 day residence; wet/low	12,251	7.0 (2.5-11.6)	0.135 (0.128-0.151)	0.462 (0.289-0.667)	3,435 (2,202-5,212)
November 4-5, 1999 70 day residence; above normal/low	6,951	17.5 (11.4-23.1)	0.123 (0.104-0.132)	0.740 (0.428-1.03)	5,986 (3,496-7,725)
November 5-6, 1997 68 day residence wet/low	9,632	16.1 (12.7-19.2)	0.210 (0.192-0.236)	0.710 (0.572-0.809)	3,381 (2,722-4,078)

[a] K_d grand mean for 1998-1999 transects = 3,317.

Table 10. Landward hydrologic conditions, Net Delta Outflow Index, salinity, observed dissolved Se concentrations, observed suspended particulate material Se concentrations, and calculated K_ds.

hydrologic condition (transect, residence time, water year/flow season)	Net Delta Outflow Index (daily average per month cfs)	salinity[a] range (psu)	observed dissolved Se mean and range (µg/L)	observed particulate Se (mean and range) µg/g dw	calculated K_d mean and range
January 22, 2003 above normal/high	50,847	0.011-8.45	0.245 (0.111-0.599)	0.411 (0.27-0.58)	2,268 (554-3,503)
January 15, 2004 below normal/high	30,924	0.012-8.105	0.215 (0.114-0.523)	0.519 (0.23-1.0)	2,981 (1,256-6,398)
April 22-23, 2003 above normal/high	21,218	0.013-3.99	0.356 (0.115-1.008)	0.614 (0.28-1.31)	2,684 (927-4,351)
October 10, 2003 below normal/low	4,350	0.019-12.68	0.174 (0.068-0.532)	0.751 (0.37-1.53)	5,855 (1,628-12,650)

[a]Calculated from chlorinity.

Table 11. Bay-Delta mean, median, 75th percentile, and 25th percentile for observed dissolved Se concentrations, observed suspended particulate material Se concentrations, and K_ds. [Arranged by increasing residence time of transect, except for November, 1997. See text for additional discussion.]

	Jun-1998 (11 day residence)	Apr-1999 (16 day residence)	Oct-1998 (22 day residence)	Nov-1999 (70 day residence)	Nov-1997 (68 day residence)
dissolved Se µg/L					
mean	0.181	0.116	0.122	0.102	0.192
75th percentile	0.204	0.128	0.134	0.122	0.215
median	0.183	0.121	0.128	0.099	0.200
25th percentile	0.148	0.093	0.105	0.085	0.163
particulate Se µg/g dw					
mean	0.518	0.636	0.712	0.746	0.842
75th percentile	0.456	0.829	0.807	0.854	1.005
median	0.392	0.528	0.627	0.725	0.783
25th percentile	0.357	0.391	0.516	0.570	0.609
K_d					
mean	3198	5824	6501	7614	4652
75th percentile	2491	7151	6525	8114	6060
median	2330	5252	4963	6569	3970
25th percentile	2059	3253	3782	5893	3173

Table 12. Suisun Bay-Carquinez Strait mean, median, 75th percentile, and 25th percentile for observed dissolved Se concentrations, observed suspended particulate material Se concentrations, and K_ds. [Arranged by increasing residence time of transect, except for November, 1997. See text for additional discussion. See Doblin et al., 2006 and Figure 14 for division into subset.]

	Jun-1998 (11 day residence)	Apr-1999 (16 day residence)	Oct-1998 (22 day residence)	Nov-1999 (70 day residence)	Nov-1997 (68 day residence)
dissolved Se µg/L					
mean	0.213	0.118	0.135	0.123	0.210
75th percentile	0.214	0.139	0.137	0.128	0.217
median	0.213	0.125	0.131	0.125	0.208
25th percentile	0.212	0.100	0.129	0.120	0.200
particulate Se µg/g dw					
mean	0.252	0.303	0.462	0.740	0.710
75th percentile	0.303	0.335	0.606	0.892	0.780
median	0.252	0.319	0.447	0.738	0.740
25th percentile	0.201	0.280	0.308	0.597	0.637
K_d					
mean	1180	2666	3435	5986	3381
75th percentile	1414	2861	4498	7089	3647
median	1180	2555	3111	6142	3378
25th percentile	946	2414	2286	5019	3091

Table 13. Comparison of predicted and observed *C. amurensis* Se concentrations during Bay-Delta transects.

transect	mean predicted clam Se µg/g dw	mean observed clam Se (all stations) (µg/g dw)	field location (station number)	mean observed clam Se by station and month (µg/g dw)
June 16-17, 1998	4.4 all salinities[a] 1.6 Carquinez Strait/Suisun Bay salinities[b]	5.4	Suisun Bay (6.1) San Pablo Bay (12.5)	Jun 5.1 Jun 5.8
April 13-14, 1999	9.5 all salinities[a] 8.7 Carquinez Strait/Suisun Bay salinities[b]	7.3	Suisun Bay (6.1) Carquinez Strait (8.1)	Mar 7.4; Apr 7.5; May 5.7; Jun 6.8 Jun 9.2
October 7-8, 1998	13.1 all salinities[a] 11.2 Carquinez Strait/Suisun Bay salinities[b]	10.8	Chipps Island (4.1) Suisun Bay (6.1) Carquinez Strait (8.1) San Pablo Bay (12.5)	Oct 5.6 Oct 12.3 Sep 15.5; Oct 13; Nov 14; Dec 14 Sep 10.5; Oct 9.6
November 4-5, 1999	12.6 all salinities[a] 12.0 Carquinez Strait/Suisun Bay salinities[b]	11.3 (12.8 Carquinez Strait data only)	Suisun Bay (6.1) Grizzly Bay (415) Grizzly Bay (411) Suisun Bay (405.1) Carquinez Strait (8.1) San Pablo Bay (12.5)	Sep 9.4; Oct 12.7; Nov 12.5 Sep 8.3; Oct 9.5; Nov 7.9 Sep 8.4; Oct 11.3; Nov 11.7; Dec 13.3 Sep 10.4; Oct 16.7; Nov 15.3 Sep 8.3; Oct 15.3; Nov 14.7 Sep 7.2; Oct 10.2; Nov 11
November 5-6, 1997	16.6 all salinities[a] 11.7 Carquinez Strait/Suisun Bay salinities[b]	14.3	Chipps Island (4.1) Suisun Bay (6.1) Carquinez Strait (8.1) San Pablo Bay (12.5)	Nov 11.6 Nov 14.0 Oct 15.5; Nov 15.3 Nov 14.9

[a] Predicted clam Se concentrations calculated with outliers deleted (TTFs>35).

[b] Table 1, Doblin et al. (2006) estuarine stations grouped into embayments: Delta; Carquinez Strait-Suisun Bay; San Pablo Bay; and Central Bay.

Table 14. Validation for existing conditions at a seaward estuary location for November, 1999 or a generalized mean condition using observed Se concentrations in seaward and landward white sturgeon; derived K_ds and TTFs; and a food web for suspended particulate material>*C. amurensis* >white sturgeon.

observed sturgeon muscle Se[a] µg/g	site-specific $TTF_{sturgeon}$	predicted *C. amurensis* Se µg/g	mean observed *C. amurensis* Se[b] µg/g	biodynamic site-specific $TTF_{C.\ amurensis}$	predicted particulate Se µg/g	observed particulate Se[c] µg/g	calculated K_d	predicted dissolved Se µg/L	observed dissolved Se[d] µg/L
10.2	1.1	9.3	12.8	17	0.545	0.428-1.66	7614(Nov 99 mean)	0.072	0.070-0.137
10.2	1.1	9.3	12.8	17	0.545	0.150-2.21	5784 (grand mean)	0.094	0.070-0.320
6.9	1.1	6.3	12.8	17	0.369	0.428-1.66	7614(Nov 99 mean)	0.048	0.070-0.137
6.9	1.1	6.3	12.8	17	0.369	0.150-2.21	5784 (grand mean)	0.064	0.070-0.320
10.2	0.8	12.8	12.8	17	0.753	0.428-1.66	7614(Nov 99 mean)	0.099	0.070-0.137
10.2	0.8	12.8	12.8	17	0.753	0.150-2.21	5784 (grand mean)	0.130	0.070-0.320
6.9	0.8	8.6	12.8	17	0.506	0.428-1.66	7614(Nov 99 mean)	0.066	0.070-0.137
6.9	0.8	8.6	12.8	17	0.506	0.150-2.21	5784 (grand mean)	0.088	0.070-0.320

[a]1998-2001 data; seaward, 10.2 µg/g; landward, 6.9 µg/g (Stewart et al., 2004);[b]Carquinez Strait (USGS station 8.1): mean observed fall 1999; note also station 405 clams, 14.6 µg/g dw Se (Kleckner et al., 2010) (see also **Table 13**); [c]1998-1999 data (Doblin et al., 2006); [d]1998-1999 data (Cutter and Cutter, 2004).

Table 15. Validation for existing conditions in Suisun Bay-Carquinez Strait for November, 1999 or a generalized mean condition using observed Se concentrations in seaward white sturgeon; derived K_ds and TTFs; and a food web for suspended particulate material>*C. amurensis* >white sturgeon.

observed sturgeon muscle Se[a] µg/g	site-specific $TTF_{sturgeon}$	predicted *C. amurensis* Se µg/g	mean observed *C. amurensis* Se[b] µg/g	biodynamic site-specific $TTF_{C.\ amurensis}$	predicted particulate Se µg/g	observed particulate Se[c] µg/g	calculated K_d	predicted dissolved Se µg/L	observed dissolved Se[d] µg/L
10.2	1.1	9.3	12.8	17	0.545	0.428-1.03	5986 (Nov 99 mean)	0.091	0.104-0.132
10.2	1.1	9.3	12.8	17	0.545	0.150-1.03	3317 (grand mean)	0.164	0.076-0.215
10.2	0.8	12.8	12.8	17	0.753	0.428-1.03	5986 (Nov 99 mean)	0.126	0.104-0.132
10.2	0.8	12.8	12.8	17	0.753	0.150-1.03	3317 (grand mean)	0.227	0.076-0.215

[a]1998-2001 data; seaward, 10.2 µg/g; landward, 6.9 µg/g (Stewart et al., 2004);[b]Carquinez Strait (USGS station 8): mean observed fall 1999; note also station 405 clams, 14.6 µg/g dw Se (Kleckner et al., 2010) (see also **Table 13**). [c]1998-1999 data (Doblin et al., 2006); [d]1998-1999 data (Cutter and Cutter, 2004).

Table 16. Validation for existing conditions at a landward estuary location for 2003-2004 using observed Se concentrations in landward largemouth bass; derived K_ds and TTFs; and a food web for suspended particulate material>aquatic insect>largemouth bass food web.

observed bass wb Se[a] µg/g	generic TTF_{fish}	predicted insect Se µg/g	mean observed chironomid Se[b] µg/g	generic TTF_{insect}	predicted particulate Se µg/g	observed particulate Se[b] µg/g	calculated K_d	predicted dissolved Se µg/L	observed dissolved Se[b] µg/L
2.9	1.1	2.6	2.7	2.8	0.942	0.27-0.58	2268 (Jan 2003 mean)	0.415	0.111-0.599
2.9	1.1	2.6	2.7	2.8	0.942	0.23-1.0	2981 (Jan 2004 mean)	0.316	0.114-0.523
2.9	1.1	2.6	2.7	2.8	0.942	0.37-1.5	5855 (Oct 2003 mean)	0.161	0.068-0.532

[a] 2007 data (Foe et al., 2010); [b]2002-2004 data (Lucas and Stewart, 2007) (see also **Appendix D, Table D5**).

Table 17. Predicted allowed dissolved Se concentrations for Bay-Delta transects at different effect guidelines and associated levels of protection (USFWS, 2009b) for a suspended particulate material>*C. amurensis*>sturgeon food web. Also shown are 1) observed dissolved Se concentrations, suspended particulate material Se concentrations, and calculated K_ds; and 2) hydrologic conditions including water-year type, flow season, residence time, and NDOI. [Assumptions: TTF_{clam} = 17.1; TTF_{fish} = 1.1. Transect data and predictions for 1998 through 1999 are arranged by increasing residence time; transect data and predictions for November, 1997 are delineated separately (see text for explanation). Means and K_ds are based on individual data points, not composites. Further studies are needed to consider sensitivity of green sturgeon].

calculated K_d mean and range	food web: particulate material > *C. amurensis* >fish	tissue	target Se (µg/g dw)	EC	predicted allowed dissolved Se mean and range (µg/L)	predicted allowed particulate Se (µg/g dw)	predicted allowed invertebrate Se (µg/g dw)	hydrologic condition (transect, residence time, water year/flow season)	observed dissolved Se mean and range (µg/L)	observed particulate Se (mean and range) µg/g dw	Net Delta Outflow Index (daily average per month cfs)
FISH (WHOLE-BODY)											
3,198 (712-11,054)	adult female white sturgeon	whole-body	8.1	10	0.208 (0.039-0.605)	0.43	7.4	June 16-17, 1998 11 day residence wet/high	0.181 (0.101-0.303)	0.518 (0.150-1.59)	73,732
5,824 (1,151-13,317)					0.110 (0.032-0.374)	0.43	7.4	April 13-14, 1999 16 day residence wetl/high	0.116 (0.076-0.165)	0.636 (0.190-1.41)	35,034
6,501 (2,202-26,912)					0.096 (0.016-0.196)	0.43	7.4	October 7-8, 1998 22 day residence wet/low	0.120 (0.077-0.164)	0.713 (0.289-2.21)	12,251
7,614 (3,496-19,785)					0.064 (0.022-0.123)	0.43	7.4	November 4-5, 1999 70 day residence above normal/low	0.102 (0.070-0.137)	0.746 (0.428-1.66)	6,951
4,652 (2,333-8,349)					0.108 (0.052-0.185)	0.43	7.4	November 5-6, 1997 68 day residence wet/low	0.192 (0.101-0.320)	0.842 (0.470-1.58)	9,632
3,198 (712-11,054)	adult female white sturgeon	whole-body	7.0	05	0.180 (0.034-0.523)	0.37	6.4	June 16-17, 1998 11 day residence wet/high	0.181 (0.101-0.303)	0.518 (0.150-1.59)	73,732
5,824 (1,151-13,317)					0.095 (0.028-0.323)	0.37	6.4	April 13-14, 1999 16 day residence wet/high	0.116 (0.076-0.165)	0.636 (0.190-1.41)	35,034
6,501 (2,202-26,912)					0.083 (0.014-0.169)	0.37	6.4	October 7-8, 1998 22 day residence wet/low	0.120 (0.077-0.164)	0.713 (0.289-2.21)	12,251
7,614 (3,496-19,785)					0.055 (0.019-0.106)	0.37	6.4	November 4-5, 1999 70 day residence above normal/low	0.102 (0.070-0.137)	0.746 (0.428-1.66)	6,951
4,652					0.093	0.37	6.4	November 5-6, 1997	0.192	0.842	9,632

calculated K_d mean and range	food web: particulate material > *C. amurensis* >fish	tissue	target Se (µg/g dw)	EC	predicted allowed dissolved Se mean and range (µg/L)	predicted allowed particulate Se (µg/g dw)	predicted allowed invertebrate Se (µg/g dw)	hydrologic condition (transect, residence time, water year/flow season)	observed dissolved Se mean and range (µg/L)	observed particulate Se (mean and range) µg/g dw	Net Delta Outflow Index (daily average per month cfs)
(2,333-8,349)					(0.045-0.160)			68 day residence wet/low	(0.101-0.320)	(0.470-1.58)	
3,198 (712-11,054)	clam-eating fish	whole-body	5.0 generic		0.128 (0.024-0.373)	0.27	4.5	June 16-17, 1998 11 day residence wet/high	0.181 (0.101-0.303)	0.518 (0.150-1.59)	73,732
5,824 (1,151-13,317)					0.068 (0.020-0.231)	0.27	4.5	April 13-14, 1999 16 day residence wet/high	0.116 (0.076-0.165)	0.636 (0.190-1.41)	35,034
6,501 (2,202-26,912)					0.059 (0.010-0.121)	0.27	4.5	October 7-8, 1998 22 day residence wet/low	0.120 (0.077-0.164)	0.713 (0.289-2.21)	12,251
7,614 (3,496-19,785)					0.040 (0.013-0.076)	0.27	4.5	November 4-5, 1999 70 day residence above normal/low	0.102 (0.070-0.137)	0.746 (0.428-1.66)	6,951
4,652 (2,333-8,349)					0.066 (0.032-0.114)	0.27	4.5	November 5-6, 1997 68 day residence wet/low	0.192 (0.101-0.320)	0.842 (0.470-1.58)	9,632
FISH (DIET)											
3,198 (712-11,054)	juvenile white sturgeon	diet	1.6 (=1.8 wb)	10	0.0452 (0.0085-0.1314)	0.094	1.6	June 16-17, 1998 11 day residence wet/high	0.181 (0.101-0.303)	0.518 (0.150-1.59)	73,732
5,824 (1,151-13,317)					0.0247 (0.0070-0.0813)	0.094	1.6	April 13-14, 1999 16 day residence wet/high	0.116 (0.076-0.165)	0.636 (0.190-1.41)	35,034
6,501 (2,202-26,912)					0.0211 (0.0035-0.0425)	0.094	1.6	October 7-8, 1998 22 day residence wet/low	0.120 (0.077-0.164)	0.713 (0.289-2.21)	12,251
7,614 (3,496-19,785)					0.0139 (0.0047-0.0268)	0.094	1.6	November 4-5, 1999 70 day residence above normal/low	0.102 (0.070-0.137)	0.746 (0.428-1.66)	6,951
4,652 (2,333-8,349)					0.0234 (0.0112-0.0401)	0.094	1.6	November 5-6, 1997 68 day residence wet/low	0.192 (0.101-0.320)	0.842 (0.470-1.58)	9,632
3,198 (712-11,054)	juvenile white sturgeon	diet	0.95 (=1.0 wb)	05	0.0268 (0.0050-0.0780)	0.056	0.95	June 16-17, 1998 11 day residence wet/high	0.181 (0.101-0.303)	0.518 (0.150-1.59)	73,732

calculated K_d mean and range	food web: particulate material *> C. amurensis* >fish	tissue	target Se (µg/g dw)	EC	predicted allowed dissolved Se mean and range (µg/L)	predicted allowed particulate Se (µg/g dw)	predicted allowed invertebrate Se (µg/g dw)	hydrologic condition (transect, residence time, water year/flow season)	observed dissolved Se mean and range (µg/L)	observed particulate Se (mean and range) µg/g dw	Net Delta Outflow Index (daily average per month cfs)
5,824 (1,151-13,317)					0.0147 (0.0042-0.0483)	0.056	0.95	April 13-14, 1999 16 day residence wet/high	0.116 (0.076-0.165)	0.636 (0.190-1.41)	35,034
6,501 (2,202-26,912)					0.0126 (0.0021-0.0252)	0.056	0.95	October 7-8, 1998 22 day residence wet/low	0.120 (0.077-0.164)	0.713 (0.289-2.21)	12,251
7,614 (3,496-19,785)					0.0082 (0.0028-0.0159)	0.056	0.95	November 4-5, 1999 70 day residence above normal/low	0.102 (0.070-0.137)	0.746 (0.428-1.66)	6,951
4,652 (2,333-8,349)					0.0139 (0.0066-0.0238)	0.056	0.95	November 5-6, 1997 68 day residence wet/low	0.192 (0.101-0.320)	0.842 (0.470-1.58)	9,632

Table 18. Predicted allowed dissolved Se concentrations for Bay-Delta transects at different effect guidelines and associated levels of protection (USFWS, 2009b) for a suspended particulate material>*C. amurensis*>clam-eating bird species food web. Also shown are 1) observed dissolved Se concentrations, suspended particulate material Se concentrations, and calculated K_ds; and 2) hydrologic conditions including water-year type, flow season, residence time, and NDOI. [Assumptions: TTF_{clam} = 17.1; TTF_{bird} = 2.6. Transect data and predictions for 1998 through 1999 are arranged by increasing residence time; transect data and predictions for November, 1997 are delineated separately (see text for explanation). Means and K_ds are based on individual data points, not composites.]

calculated K_d mean and range	food web: particulate> *C. amurensis* >bird	tissue	target Se (µg/g dw)	EC	predicted allowed dissolved Se mean and range (µg/L)	predicted allowed particulate Se (µg/g dw)	predicted allowed invertebrate Se (µg/g dw)	hydrologic condition (transect, residence time, water year/flow season)	observed dissolved Se mean and range (µg/L)	observed particulate Se (mean and range) µg/g dw	Net Delta Outflow Index (daily average per month cfs)
BIRD (EGG)											
3,198 (712-11,054)	scoter and scaup	egg	7.7 generic	10	0.0837 (0.0157-0.243)	0.17	3.0	June 16-17, 1998 11 day residence wet/high	0.181 (0.101-0.303)	0.518 (0.150-1.59)	73,732
5,824 (1,151-13,317)					0.0440 (0.0130-0.1505)	0.17	3.0	April 13-14, 1999 16 day residence wet/ high	0.116 (0.076-0.165)	0.636 (0.190-1.41)	35,034
6,501 (2,202-26,912)					0.0404 (0.0064-0.0786)	0.17	3.0	October 7-8, 1998 22 day residence wet/low	0.120 (0.077-0.164)	0.713 (0.289-2.21)	12,251
7,614 (3,496-19,785)					0.0258 (0.0088-0.0495)	0.17	3.0	November 4-5, 1999 70 day residence above normal/low	0.102 (0.070-0.137)	0.746 (0.428-1.66)	6,951
4,652 (2,333-8,349)					0.0432 (0.0207-0.0742)	0.17	3.0	November 5-6, 1997 68 day residence wet/low	0.192 (0.101-0.320)	0.842 (0.470-1.58)	9,632
3,198 (712-11,054	scoter and scaup	egg	5.9	05	0.0641 (0.0120-0.1864)	0.13	2.3	June 16-17, 1998 11 day residence wet/high	0.181 (0.101-0.303)	0.518 (0.150-1.59)	73,732
5,824 (1,151-13,317)					0.0337 (0.0100-0.1153)	0.13	2.3	April 13-14, 1999 16 day residence wet/high	0.116 (0.076-0.165)	0.636 (0.190-1.41)	35,034
6,501 (2,202-26,912)					0.0310 (0.0049-0.0603)	0.13	2.3	October 7-8, 1998 22 day residence wet/low	0.120 (0.077-0.164)	0.713 (0.289-2.21)	12,251
7,614 (3,496-19,785)					0.0197 (0.0067-0.0380)	0.13	2.3	November 4-5, 1999 70 day residence above normal/low	0.102 (0.070-0.137)	0.746 (0.428-1.66)	6,951
4,652 (2,333-8,349)					0.0331 (0.0159-0.0596)	0.13	2.3	November 5-6, 1997 68 day residence wet/low	0.192 (0.101-0.320)	0.842 (0.470-1.58)	9,632

calculated K_d mean and range	food web: particulate> *C. amurensis* >bird	tissue	target Se (µg/g dw)	EC	predicted allowed dissolved Se mean and range (µg/L)	predicted allowed particulate Se (µg/g dw)	predicted allowed invertebrate Se (µg/g dw)	hydrologic condition (transect, residence time, water year/flow season)	observed dissolved Se mean and range (µg/L)	observed particulate Se (mean and range) µg/g dw	Net Delta Outflow Index (daily average per month cfs)
3,198 (712-11,054	scoter and scaup	egg	2.8	0	0.0304 (0.0057-0.0884)	0.063	1.1	June 16-17, 1998 11 day residence wet/high	0.181 (0.101-0.303)	0.518 (0.150-1.59)	73,732
5,824 (1,151-13,317)					0.0160 (0.0047-0.0547)	0.063	1.1	April 13-14, 1999 16 day residence wet/high	0.116 (0.076-0.165)	0.636 (0.190-1.41)	35,034
6,501 (2,202-26,912)					0.0140 (0.0023-0.0286)	0.063	1.1	October 7-8, 1998 22 day residence wet/low	0.120 (0.077-0.164)	0.713 (0.289-2.21)	12,251
7,614 (3,496-19,785)					0.0094 (0.0032-0.0180)	0.063	1.1	November 4-5, 1999 70 day residence above normal/low	0.102 (0.070-0.137)	0.746 (0.428-1.66)	6,951
4,652 (2,333-8,349)					0.0157 (0.0075-0.0270)	0.063	1.1	November 5-6, 1997 68 day residence wet/low	0.192 (0.101-0.320)	0.842 (0.470-1.58)	9,632
BIRD (DIET)											
3,198 (712-11,054	scoter and scaup	diet	5.3 (=13.8 egg)	10	0.1498 (0.0280-0.4353)	0.31	5.3	June 16-17, 1998 11 day residence wet/high	0.181 (0.101-0.303)	0.518 (0.150-1.59)	73,732
5,824 (1,151-13,317)					0.0818 (0.0233-0.2693)	0.31	5.3	April 13-14, 1999 16 day residence wet/high	0.116 (0.076-0.165)	0.636 (0.190-1.41)	35,034
6,501 (2,202-26,912)					0.0700 (0.0115-0.1408)	0.31	5.3	October 7-8, 1998 22 day residence wet/low	0.120 (0.077-0.164)	0.713 (0.289-2.21)	12,251
7,614 (3,496-19,785)					0.0460 (0.0157-0.0886)	0.31	5.3	November 4-5, 1999 70 day residence above normal/low	0.102 (0.070-0.137)	0.746 (0.428-1.66)	6,951
4,652 (2,333-8,349)					0.0774 (0.0371-0.1328)	0.31	5.3	November 5-6, 1997 68 day residence wet/low	0.192 (0.101-0.320)	0.842 (0.470-1.58)	9,632
3,198 (712-11,054	scoter and scaup	diet	4.4 (=11.4 egg)	05	0.1244 (0.0233-0.3613)	0.26	4.4	June 16-17, 1998 11 day residence wet/high	0.181 (0.101-0.303)	0.518 (0.150-1.59)	73,732
5,824 (1,151-13,317)					0.0679 (0.0193-0.2235)	0.26	4.4	April 13-14, 1999 16 day residence	0.116 (0.076-0.165)	0.636 (0.190-1.41)	35,034

calculated K_d mean and range	food web: particulate> *C. amurensis* >bird	tissue	target Se (µg/g dw)	EC	predicted allowed dissolved Se mean and range (µg/L)	predicted allowed particulate Se (µg/g dw)	predicted allowed invertebrate Se (µg/g dw)	hydrologic condition (transect, residence time, water year/flow season)	observed dissolved Se mean and range (µg/L)	observed particulate Se (mean and range) µg/g dw	Net Delta Outflow Index (daily average per month cfs)
								wet/high			
6,501 (2,202-26,912)					0.0581 (0.0096-0.1168)	0.26	4.4	October 7-8, 1998 22 day residence wet/low	0.120 (0.077-0.164)	0.713 (0.289-2.21)	12,251
7,614 (3,496-19,785)					0.0382 (0.0130-0.0736)	0.26	4.4	November 4-5, 1999 70 day residence above normal/low	0.102 (0.070-0.137)	0.746 (0.428-1.66)	6,951
4,652 (2,333-8,349)					0.0642 (0.0308-0.1103)	0.26	4.4	November 5-6, 1997 68 day residence wet/low	0.192 (0.101-0.320)	0.842 (0.470-1.58)	9,632
3,198 (712-11,054	scoter and scaup	diet	2.3 (=6.0 egg)	0	0.0650 (0.0122-0.1889)	0.13	2.3	June 16-17, 1998 11 day residence wet/high	0.181 (0.101-0.303)	0.518 (0.150-1.59)	73,732
5,824 (1,151-13,317)					0.0355 (0.0101-0.1169)	0.13	2.3	April 13-14, 1999 16 day residence wet/high	0.116 (0.076-0.165)	0.636 (0.190-1.41)	35,034
6,501 (2,202-26,912)					0.0304 (0.0050-0.0611)	0.13	2.3	October 7-8, 1998 22 day residence wet/low	0.120 (0.077-0.164)	0.713 (0.289-2.21)	12,251
7,614 (3,496-19,785)					0.0200 (0.0068-0.0385)	0.13	2.3	November 4-5, 1999 70 day residence above normal/low	0.102 (0.070-0.137)	0.746 (0.428-1.66)	6,951
4,652 (2,333-8,349)					0.0336 (0.0161-0.0576)	0.13	2.3	November 5-6, 1997 68 day residence wet/low	0.192 (0.101-0.320)	0.842 (0.470-1n58)	9,632

Table 19. Predicted allowed dissolved Se concentrations for landward transects at different effect guidelines and associated levels of protection (USFWS, 2009b) for a suspended particulate material>aquatic insect>juvenile salmon food web. Also shown are 1) observed dissolved Se concentrations, suspended particulate material Se concentrations, and calculated K_ds; and 2) hydrologic conditions including water-year type, flow season, and NDOI. [Assumptions: TTF_{fish} = 1.1; $TTF_{aquatic\ insect}$ = 2.8. Means and K_ds are based on individual data points, not composites.]

calculated K_d mean and range	food web: particulate >insect >fish	tissue	target Se (µg/g dw)	EC	predicted allowed dissolved Se mean and range (µg/L)	predicted allowed particulate Se (µg/g dw)	predicted allowed invertebrate Se (µg/g dw)	hydrologic condition (transect, water year/flow season)	observed dissolved Se mean and range (µg/L)	observed particulate Se mean and range (µg/g dw)	Net Delta Outflow Index (daily average per month cfs)
FISH (WHOLE-BODY)											
2,268 (554-3,503)	insect-eating fish	whole-body	5.0 generic		1.05 (0.463-2.93)	1.6	4.5	January 22, 2003 above normal/high	0.245 (0.111-0.599)	0.411 (0.27-0.58)	50,847
2,981 (1,256-6,398)					0.701 (0.254-1.29)	1.6	4.5	January 15, 2004 below normal/high	0.215 (0.114-0.523)	0.519 (0.23-1.0)	30,924
2,684 (927-4,351)					0.772 (0.373-1.75)	1.6	4.5	April 22-23, 2003 above normal/high	0.356 (0.115-1.008)	0.614 (0.28-1.31)	21,218
5,855 (1,628-12,650)					0.382 (0.128-0.997)	1.6	4.5	October 10, 2003 below normal/low	0.174 (0.068-0.532)	0.751 (0.37-1.53)	4,350
2,268 (554-3,503)	juvenile salmon	whole-body	1.8	10	0.388 (0.170-1.078)	0.60	1.6	January 22, 2003 above normal/high	0.245 (0.111-0.599)	0.411 (0.27-0.58)	50,847
2,981 (1,256-6,398)					0.258 (0.0934-0.476)	0.60	1.6	January 15, 2004 below normal/high	0.215 (0.114-0.523)	0.519 (0.23-1.0)	30,924
2,684 (927-4,351)					0.284 (0.137-0.644)	0.60	1.6	April 22-23, 2003 above normal/high	0.356 (0.115-1.008)	0.614 (0.28-1.31)	21,218
5,855 (1,628-12,650)					0.140 (0.0472-0.367)	0.60	1.6	October 10, 2003 below normal/low	0.174 (0.068-0.532)	0.751 (0.37-1.53)	4,350
2,268 (554-3,503)	juvenile salmon	whole-body	1.5	05	0.316 (0.139-0.897)	0.50	1.4	January 22, 2003 above normal/high	0.245 (0.111-0.599)	0.411 (0.27-0.58)	50,847
2,981 (1,256-6,398)					0.210 (0.0761-0.388)	0.50	1.4	January 15, 2004 below normal/high	0.215 (0.114-0.523)	0.519 (0.23-1.0)	30,924
2,684 (927-4,351)					0.232 (0.112-0.525)	0.50	1.4	April 22-23, 2003 above normal/high	0.356 (0.115-1.008)	0.614 (0.28-1.31)	21,218
5,855 (1,628-12,650)					0.114 (0.0385-0.299)	0.50	1.4	October 10, 2003 below normal/low	0.174 (0.068-0.532)	0.751 (0.37-1.53)	4,350
2,268 (554-3,503)	juvenile salmon	whole-body	1.0	0	0.211 (0.0927-0.586)	0.33	0.91	January 22, 2003 above normal/high	0.245 (0.111-0.599)	0.411 (0.27-0.58)	50,847
2,981 (1,256-6,398)					0.140 (0.0507-0.258)	0.33	0.91	January 15, 2004 below normal/high	0.215 (0.114-0.523)	0.519 (0.23-1.0)	30,924

calculated K_d mean and range	food web: particulate >insect >fish	tissue	target Se (µg/g dw)	EC	predicted allowed dissolved Se mean and range (µg/L)	predicted allowed particulate Se (µg/g dw)	predicted allowed invertebrate Se (µg/g dw)	hydrologic condition (transect, water year/flow season)	observed dissolved Se mean and range (µg/L)	observed particulate Se mean and range (µg/g dw)	Net Delta Outflow Index (daily average per month cfs)
2,684 (927-4,351)					0.154 (0.0746-0.350)	0.33	0.91	April 22-23, 2003 above normal/high	0.356 (0.115-1.008)	0.614 (0.28-1.31)	21,218
5,855 (1,628-12,650)					0.076 (0.0257-0.199)	0.33	0.91	October 10, 2003 below normal/low	0.174 (0.068-0.532)	0.751 (0.37-1.53)	4,350
FISH (DIET)											
2,268 (554-3,503)	juvenile salmon	diet	2.7 (=3.0 wb)	10	0.632 (0.278-1.758)	0.97	2.7	January 22, 2003 above normal/high	0.245 (0.111-0.599)	0.411 (0.27-0.58)	50,847
2,981 (1,256-6,398)					0.421 (0.152-0.775)	0.97	2.7	January 15, 2004 below normal/high	0.215 (0.114-0.523)	0.519 (0.23-1.0)	30,924
2,684 (927-4,351)					0.463 (0.224-1.051)	0.97	2.7	April 22-23, 2003 above normal/high	0.356 (0.115-1.008)	0.614 (0.28-1.31)	21,218
5,855 (1,628-12,650)					0.229 (0.0770-0.598)	0.97	2.7	October 10, 2003 below normal/low	0.174 (0.068-0.532)	0.751 (0.37-1.53)	4,350
2,268 (554-3,503)	juvenile salmon	diet	2.2 (=2.4 wb)	05	0.506 (0.222-1.406)	0.80	2.2	January 22, 2003 above normal/high	0.245 (0.111-0.599)	0.411 (0.27-0.58)	50,847
2,981 (1,256-6,398)					0.337 (0.122-0.620)	0.80	2.2	January 15, 2004 below normal/high	0.215 (0.114-0.523)	0.519 (0.23-1.0)	30,924
2,684 (927-4,351)					0.371 (0.179-0.841)	0.80	2.2	April 22-23, 2003 above normal/high	0.356 (0.115-1.008)	0.614 (0.28-1.31)	21,218
5,855 (1,628-12,650)					0.183 (0.0616-0.479)	0.80	2.2	October 10, 2003 below normal/low	0.174 (0.068-0.532)	0.751 (0.37-1.53)	4,350
2,268 (554-3,503)	juvenile salmon	diet	1.5 (=1.65 wb)	0	0.348 0.153-0.967	0.54	1.5	January 22, 2003 above normal/high	0.245 (0.111-0.599)	0.411 (0.27-0.58)	50,847
2,981 (1,256-6,398)					0.231 0.0837-0.426	0.54	1.5	January 15, 2004 below normal/high	0.215 (0.114-0.523)	0.519 (0.23-1.0)	30,924
2,684 (927-4,351)					0.255 0.123-0.578	0.54	1.5	April 22-23, 2003 above normal/high	0.356 (0.115-1.008)	0.614 (0.28-1.31)	21,218
5,855 (1,628-12,650)					0.126 0.0423-0.329	0.54	1.5	October 10, 2003 below normal/low	0.174 (0.068-0.532)	0.751 (0.37-1.53)	4,350

Table 20. Prediction scenarios using Suisun Bay-Carquinez Strait transects for a suspended particulate material>*C. amurensis*>white sturgeon food web.

fish Se target (µg/g wb, dw)	K_d	predicted dissolved Se µg/L	predicted particulate Se µg/g	predicted prey Se µg/g
TTF_{fish} = 1.1; TTF_{clam} = 17				
8	1,180 (June 98, 11 days)	0.363	0.428	7.27
5		0.227	0.267	4.55
1.8		0.082	0.096	1.64
8	2,666 (Apr 99, 16 days)	0.160	0.428	7.27
5		0.100	0.267	4.55
1.8		0.036	0.096	1.64
8	3,435 (Oct 98, 22 days)	0.125	0.428	7.27
5		0.078	0.267	4.55
1.8		0.028	0.096	1.64
8	5,986 (Nov 99, 70 days)	0.071	0.428	7.27
5		0.045	0.267	4.55
1.8		0.016	0.096	1.64
TTF_{fish} = 1.1; $TTF_{clam + amphipod}$ = 8.8[a]				
8	1,180 (June 98, 11 days)	0.700	0.826	7.27
5		0.438	0.517	4.55
1.8		0.158	0.186	1.64
8	2,666 (Apr 99, 16 days)	0.310	0.826	7.27
5		0.194	0.517	4.55
1.8		0.070	0.186	1.64
8	3,435 (Oct 98, 22 days)	0.241	0.826	7.27
5		0.150	0.517	4.55
1.8		0.054	0.186	1.64
8	5,986 (Nov 99, 70 days)	0.138	0.826	7.27
5		0.086	0.517	4.55
1.8		0.031	0.186	1.64
TTF_{fish} = 0.8; TTF_{clam} = 17				
8	1,180 (June 98, 11 days)	0.499	0.588	10
5		0.312	0.368	6.25
1.8		0.112	0.132	2.25
8	2,666 (Apr 99, 16 days)	0.221	0.588	10
5		0.138	0.368	6.25
1.8		0.050	0.132	2.25
8	3,435 (Oct 98, 22 days)	0.171	0.588	10
5		0.107	0.368	6.25
1.8		0.039	0.132	2.25
8	5,986 (Nov 99, 70 days)	0.098	0.588	10
5		0.061	0.368	6.25

fish Se target (µg/g wb, dw)	K_d	predicted dissolved Se µg/L	predicted particulate Se µg/g	predicted prey Se µg/g
1.8		0.022	0.132	2.25
TTF_{fish} = 0.8; $TTF_{clam + amphipod}$ = 8.8 [a]				
8	1,180 (June 98, 11 days)	0.963	1.14	10
5		0.602	0.710	6.25
1.8		0.217	0.256	2.25
8	2,666 (Apr 99, 16 days)	0.426	1.14	10
5		0.266	0.710	6.25
1.8		0.096	0.256	2.25
8	3,435 (Oct 98, 22 days)	0.331	1.14	10
5		0.207	0.710	6.25
1.8		0.074	0.256	2.25
8	5,986 (Nov 99, 70 days)	0.190	1.14	10
5		0.119	0.710	6.25
1.8		0.043	0.256	2.25

[a] TTF = 8.8 is a composite TTF of TTF_{clam} + $TTF_{amphipod}$ where diet is assumed as 50% *C. amurensis* (TTF = 17) and 50% amphipod (TTF = 0.6). Predicted prey concentrations also are a composite that would need to be separated into components to assess the allowable *C.* amurensis Se concentration and the allowable amphipod Se concentration.

Table 21. Prediction scenarios using Suisun Bay-Carquinez Strait transects for a suspended particulate material>*C. amurensis*>clam-eating bird species food web.

bird egg Se target (µg/g wb, dw)	K_d	predicted dissolved Se µg/L	predicted particulate Se µg/g	predicted prey Se µg/g
$TTF_{bird\ egg}$ = 2.6; TTF_{clam} = 17				
12	1,180 (June 98, 11 days)	0.230	0.271	4.62
7.7		0.148	0.174	2.96
5.9		0.113	0.133	2.27
12	2,666 (Apr 99, 16 days)	0.102	0.271	4.62
7.7		0.065	0.174	2.96
5.9		0.050	0.133	2.27
12	3,435 (Oct 98, 22 days)	0.079	0.271	4.62
7.7		0.051	0.174	2.96
5.9		0.039	0.133	2.27
12	5,986 (Nov 99, 70 days)	0.045	0.271	4.62
7.7		0.029	0.174	2.96
5.9		0.022	0.133	2.27
$TTF_{bird\ egg}$ = 2.6; $TTF_{clam + amphipod}$ = 8.8 [a]				
12	1,180 (June 98, 11 days)	0.444	0.524	4.62
7.7		0.285	0.337	2.96
5.9		0.219	0.258	2.27
12	2,666 (Apr 99, 16 days)	0.197	0.524	4.62
7.7		0.126	0.337	2.96
5.9		0.097	0.258	2.27
12	3,435 (Oct 98, 22 days)	0.153	0.524	4.62
7.7		0.098	0.337	2.96
5.9		0.075	0.258	2.27
12	5,986 (Nov 99, 70 days)	0.088	0.524	4.62
7.7		0.056	0.337	2.96
5.9		0.043	0.258	2.27

[a] TTF = 8.8 is a composite TTF of TTF_{clam} + $TTF_{amphipod}$ where diet is assumed as 50% *C. amurensis* (TTF = 17) and 50% amphipod (TTF = 0.6). Predicted prey concentrations also are a composite that would need to be separated into components to assess the allowable *C.* amurensis Se concentration and the allowable amphipod Se concentration.

Table 22. Prediction scenarios using landward-focused transects for suspended particulate material>aquatic insect>juvenile salmon or steelhead.

fish Se target (µg/g wb, dw)	K_d	predicted dissolved Se µg/L	predicted particulate Se µg/g	predicted prey Se µg/g
TTF_{fish} = 1.1; $TTF_{aquatic\ insect}$ = 2.8				
8	2268 (50,847 cfs)	1.145	2.597	7.27
5		0.716	1.623	4.55
1.8		0.258	0.584	1.64
8	2981 (30,924 cfs)	0.871	2.597	7.27
5		0.545	1.623	4.55
1.8		0.196	0.584	1.64
8	2684 (21,218 cfs)	0.968	2.597	7.27
5		0.605	1.623	4.55
1.8		0.218	0.584	1.64
8	5855 (4,350 cfs)	0.444	2.597	7.27
5		0.277	1.623	4.55
1.8		0.100	0.584	1.64

Table 23. Prediction scenarios using landward-focused transects for suspended particulate material>aquatic insect>rail.

fish Se target (µg/g wb, dw)	K_d	predicted dissolved Se µg/L	predicted particulate Se µg/g	predicted prey Se µg/g
$TTF_{bird\ egg}$ = 2.6; $TTF_{aquatic\ insect}$ = 2.8				
12	2268 (50,847 cfs)	0.727	1.648	4.62
7.7		0.466	1.058	2.96
5.9		0.357	0.810	2.27
12	2981 (30,924 cfs)	0.553	1.648	4.62
7.7		0.355	1.058	2.96
5.9		0.272	0.810	2.27
12	2684 (21,218 cfs)	0.614	1.648	4.62
7.7		0.394	1.058	2.96
5.9		0.302	0.810	2.27
12	5855 (4,350 cfs)	0.282	1.648	4.62
7.7		0.181	1.058	2.96
5.9		0.138	0.810	2.27