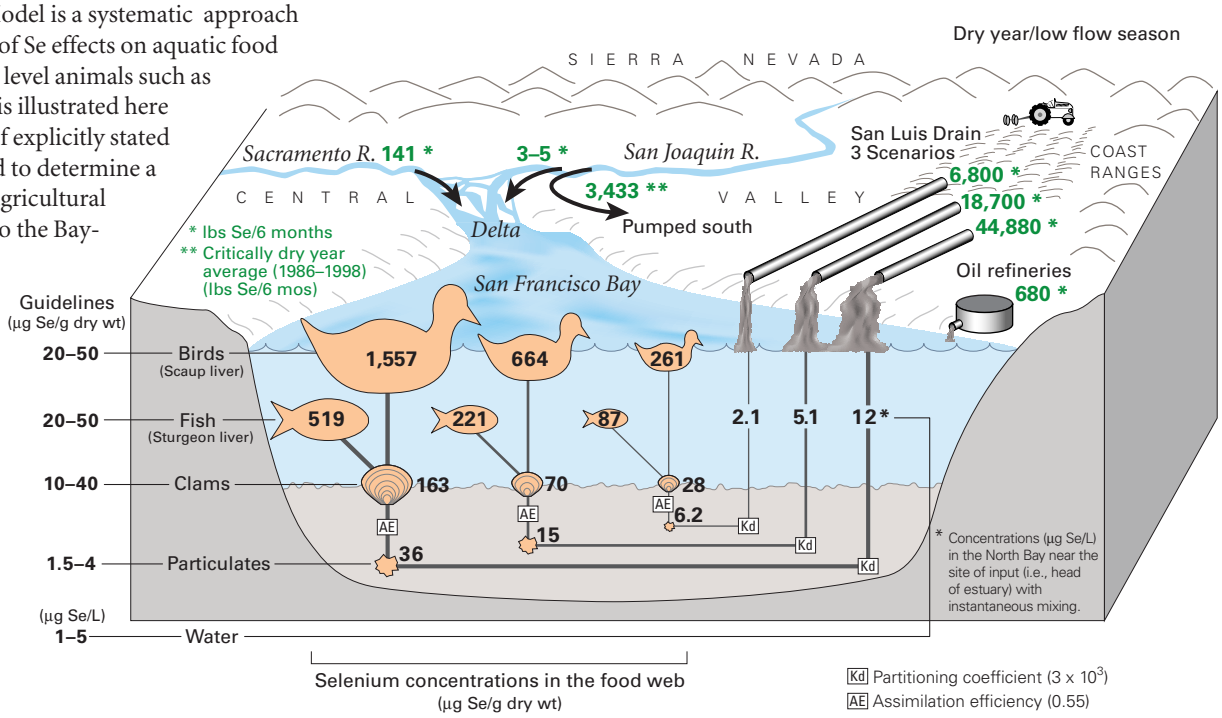
Example Selenium Forecast for the Bay-Delta

The Bay-Delta Selenium Model is a systematic approach for conducting forecasts of Se effects on aquatic food webs including higher trophic level animals such as birds and fish. The approach is illustrated here and can be used with any set of explicitly stated conditions. Major inputs used to determine a composite input load are (1) agricultural drainage via direct discharge to the Bay-Delta; (2) effluents from the North Bay refineries; (3) San Joaquin River inflows which include agricultural drainage; and (4) Sacramento River inflows. The Se load delivered to the Bay also depends on the amount of flow from the San Joaquin River that passes through the Delta and the amount recycled south through the Delta and Tracy pumping stations. The protocol for linking Se load and Se concentration under assigned hydraulic conditions and time duration is:



composite freshwater endmember concentration = composite input load/composite input volume

The projections or outputs of the model are presented by season, where a season is defined as six months of predominantly high river inflows (December through May) or six months of predominantly low river inflows (June through November). Riverine influences also depend upon water year type. In combination with flow seasons, forecasts are made for critically dry years or for wet years. A wide range of agricultural Se input loads is possible, depending upon which management strategies are chosen. Potential ranges of annual input loads were derived assuming Se discharge was continuous and are presented here as discharged load per six months (i.e. one-half the annual load under a constant rate of loading).

An example forecast is shown in the figure for a dry year during the low flow season and with conveyance through a San Luis Drain extension directly to the Bay-Delta. The dry years and low flow seasons will be the ecological bottleneck (the times that will drive impacts) with regard to Se. Surf scoter, greater and lesser scaup, and white sturgeon are present in the estuary during the low flow season and leave before high flows subside. Animals preparing for reproduction, or for which early life stages develop in September through March, will be vulnerable.

The figure shows Se concentrations for each media forecast (water, particulate, invertebrate, predator), along with guidelines or concentrations where biotic effects are expected (Luoma and Presser, 2000). The forecasts show conditions at the head of the estuary for a range of inputs (6,800; 18,700; or 44,880 lbs Se released per six months) from the San Luis Drain and for a small amount of San Joaquin River inflow to the Bay. The input from oil refineries is assumed constant at 680 lbs Se per six months. We assume a partitioning coefficient (Kd) of 3×10^3 typical of Bay-Delta shallow sediment conditions and a generic bivalve assimilation efficiency (AE) of 0.55 to reflect particulate transformation and bioaccumulation potential from a sediment with a mixture of forms.

In general, the lowest guideline values for waterborne, particulate, dietary, and predator tissue Se are exceeded in every forecast considered in the figure where the input is from a proposed San Luis Drain extension. The highest guidelines from the literature are exceeded in all forecasts except that for the lowest load considered (6,800 lbs per six months) where exceedance does occur for particulates, white sturgeon and greater and lesser scaup liver. If a San Luis Drain extension is constructed and if it discharges the quantities of Se in our scenarios, during low flow seasons, a high hazard seems likely, with threats to fish and bird species under the load scenarios tested here.

Forecasts also were conducted for loading via the San Joaquin River. If careful management of an out-of-valley resolution to the drainage problem results in discharges of Se via the San Joaquin River to the Bay-Delta (for example at 3,500 lbs per six months), the risks are less than those forecast for a San Luis Drain extension. Under the low flow season of a dry year scenario, the Se concentrations forecast in prey and predators are similar to Se concentrations observed during conditions in the Bay-Delta prior to refinery cleanup. Selenium contamination documented from 1986 to 1996 was sufficient to threaten reproduction in key species within the Bay-Delta estuary ecosystems and resulted in human health advisories being posted for consumption of those species.

Forecasting Selenium Discharges to the San Francisco Bay-Delta Estuary: Ecological Effects of A Proposed San Luis Drain Extension, by Samuel N. Luoma and Theresa S. Presser, U.S. Geological Survey Open-File Report 00-416.