

X₂ Update

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This article describes the variation in X₂ over the last 4 years and brings up to date the relationships between abundance or survival of various species and X₂ described by Jassby *et al* (1995).

X₂ is the distance from the Golden Gate to the point at which daily average salinity is 2 parts per thousand at the bottom. X₂ was calculated for 1968-1991 by interpolating surface salinity values from a series of continuous monitoring stations and correcting for stratification (Jassby *et al* 1995). The resulting daily time series and the monthly means were then fit to time series models to predict X₂ from net delta outflow and the previous day's (or month's) X₂. These models were then used to extend the X₂ time series to the end of water year 1994 using delta outflow from the DAYFLOW model, and through water year 1995 using estimates of daily outflow provided by DWR.

Abundance data were obtained from DFG either as annual abundance indices or as abundance estimates that were averaged by year. Models identical to those reported by Jassby *et al* (1995) were fit to the data for the same period (typically through 1990 or 1991), and the points added after that were inspected for deviation from the values predicted by the models.

Figure 1 shows the entire time series of X₂ values (A) and a subset for 1991-1995 (B). The effects of high- and low-flow periods are apparent in both graphs. Prominent features in the longer time series are the intense 1976-1977 drought and the less intense but longer drought of 1987-1992. High-flow periods appear as downward spikes in the data, as in 1983 and 1986. In 1993 and 1995, spring floods pushed X₂ downstream to the western margin of Suisun Bay (56 km) and beyond; in 1994 and other dry years, X₂ remained east of Chippis Island (74 km) for most of the year.

Most of the relationships between X₂ and biological variables have continued to hold, with highly significant relationships to X₂ for longfin smelt, starry flounder, striped bass, and *Crangon franciscorum* abundance indices, *Neomysis mercedis* abundance, and striped bass survival index from egg to young-of-the-year. In addition, splittail abundance index and abundance of total copepods have a significant relationship to X₂ not previously identified. Abundance of the copepod *Eurytemora affinis* was related to X₂ if year was added as a covariate, implying a decline in abundance as well as a relationship to flow.

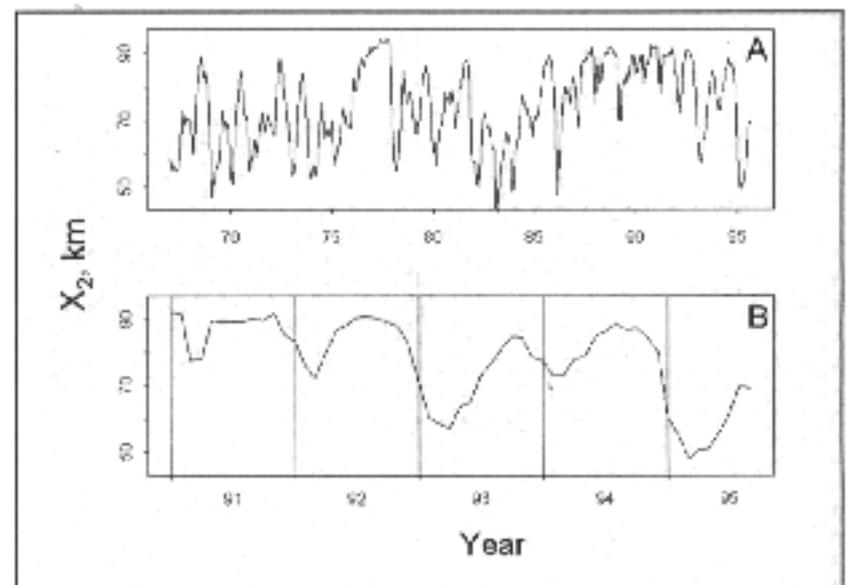


Figure 1
Time Series of Monthly Estimates of X₂ for
Calendar Years 1967-1995 (A) and 1991-1995 (B)

Figure 2 shows four of the relationships and indicates the points occurring after the period examined by Jassby *et al* (1995). For *Neomysis mercedis*, all points after 1988 fell below the line, probably because of competition with *Potamocorbula amurensis*. Similarly, all of the points for *Crangon franciscorum* since 1990 fell below the line. This could be due to reduction in food supply, although this issue has not been addressed for this species. Starry flounder and longfin smelt (not shown) likewise have

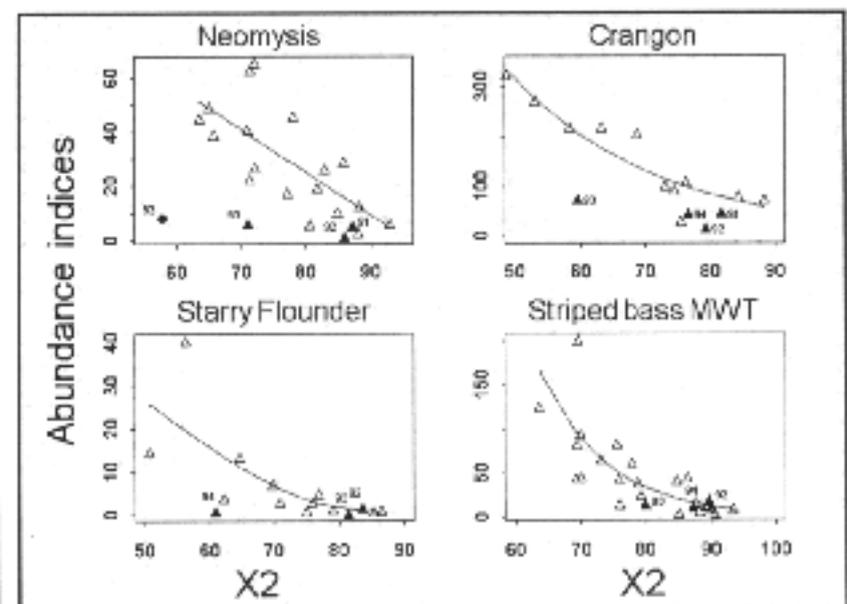


Figure 2
Relationships of X₂ to
Annual Mean Abundance of *Neomysis mercedis*,
Annual Abundance Indices of *Crangon franciscorum* and
Starry Flounder, and
Striped Bass Midwater Trawl Index.

Solid triangles indicate points not included in the original models; numbers indicate years. The single point for 1993 in the *Neomysis* graph was not used in fitting the line. See Jassby *et al* (1995) for details of methods used to fit lines to the data.