

# Salinity and Temperature

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## Salinity

The estuary is a series of mixing bowls receiving inputs of freshwater primarily from the Sacramento and San Joaquin rivers and inputs of marine water through the Golden Gate. River outflow (at Chipps Island in Suisun Bay) was highest in winter and spring and varied greatly from year to year (see Figure 2 in the Introduction chapter). The early years of the study were classified as “wet” water years (California Department of Water Resources classification), but after 1986 an extended drought lasted until 1993. Of the 17 years sampled, 9 were classified as “dry” or “critically dry,” 7 as wet, and 1 was “above normal” (Table 1).

Salinity was highest in South and Central bays, frequently exceeding 30‰ both on surface and at bottom (Figures 1 and 2). San Pablo Bay was much fresher—even bottom salinities never exceeded 29‰ and during exceptionally high freshwater flows in 1982, 1983, and 1986, dropped below 2‰ at all depths (Figure 3). In Suisun Bay, salinities <10‰ were common except during the drought of 1987–1992, and salinities >15‰ were rare at any depth (Figure 4). The west delta was usually fresh (<0.5‰) prior to 1987, but was rarely so during the 7-year drought (Figure 5). The highest west delta salinity was about 8‰ in 1989. High freshwater outflow reduced salinity but increased salinity stratification from Suisun Bay seaward.

**Table 4 Classification of water year type from 1980 to 1996**

<i>Year</i>	<i>Classification</i>
1980	Wet
1981	Dry
1982	Wet
1983	Wet
1984	Wet
1985	Dry
1986	Wet
1987	Critically Dry
1988	Critically Dry
1989	Dry
1990	Critically Dry
1991	Critically Dry
1992	Critically Dry
1993	Above Normal
1994	Critically Dry
1995	Wet
1996	Wet

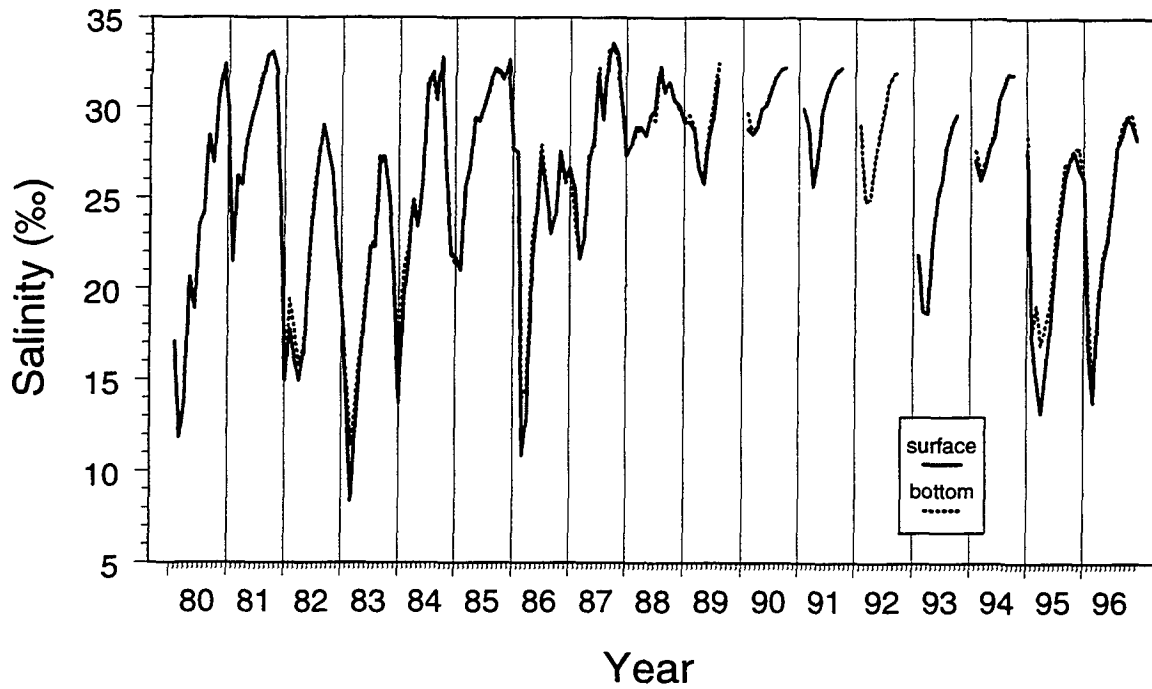


Figure 1 Monthly surface and bottom salinity in South San Francisco Bay from 1980 to 1996

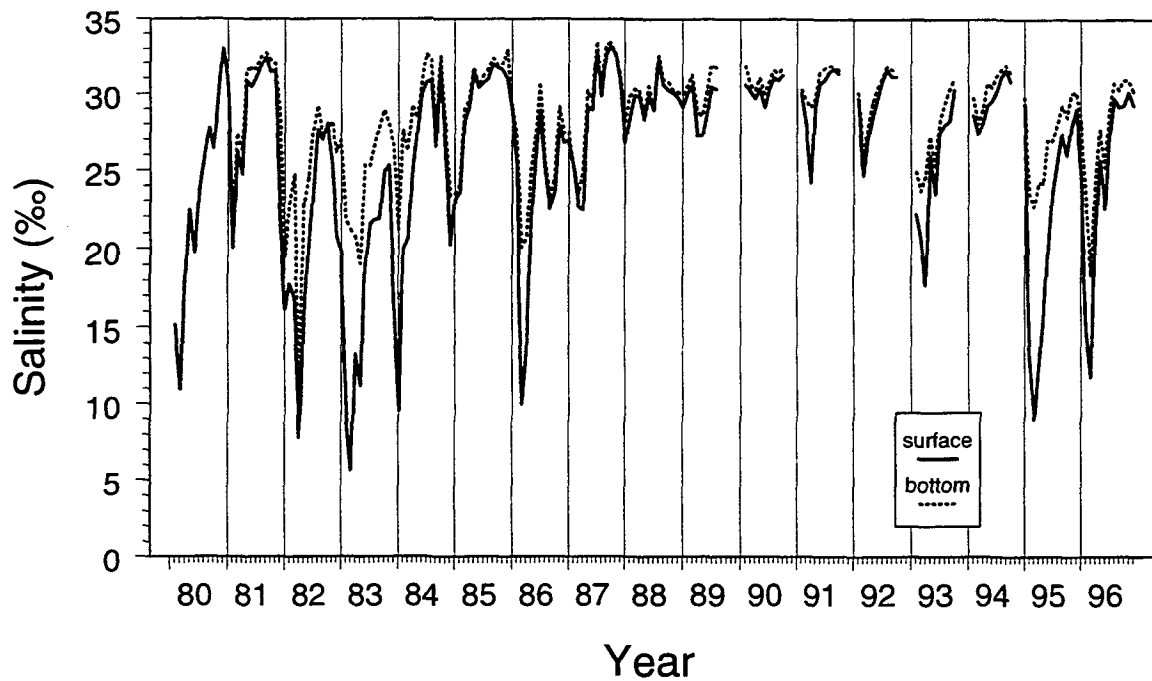


Figure 2 Monthly surface and bottom salinity in Central San Francisco Bay from 1980 to 1996

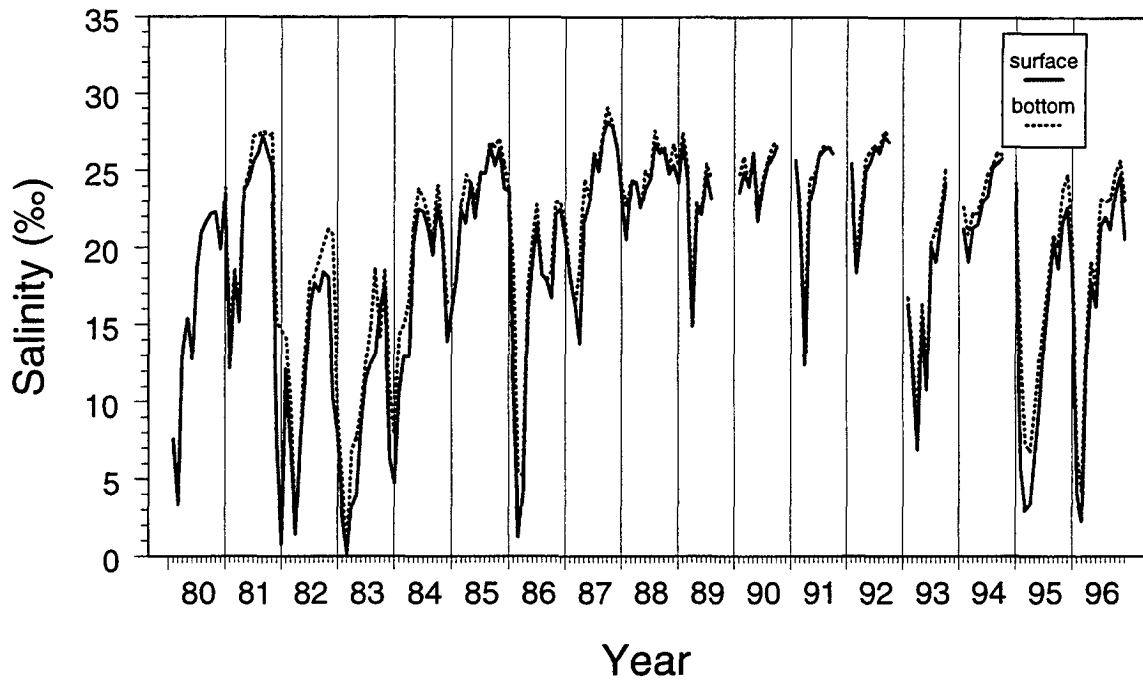


Figure 3 Monthly surface and bottom salinity in San Pablo Bay from 1980 to 1996

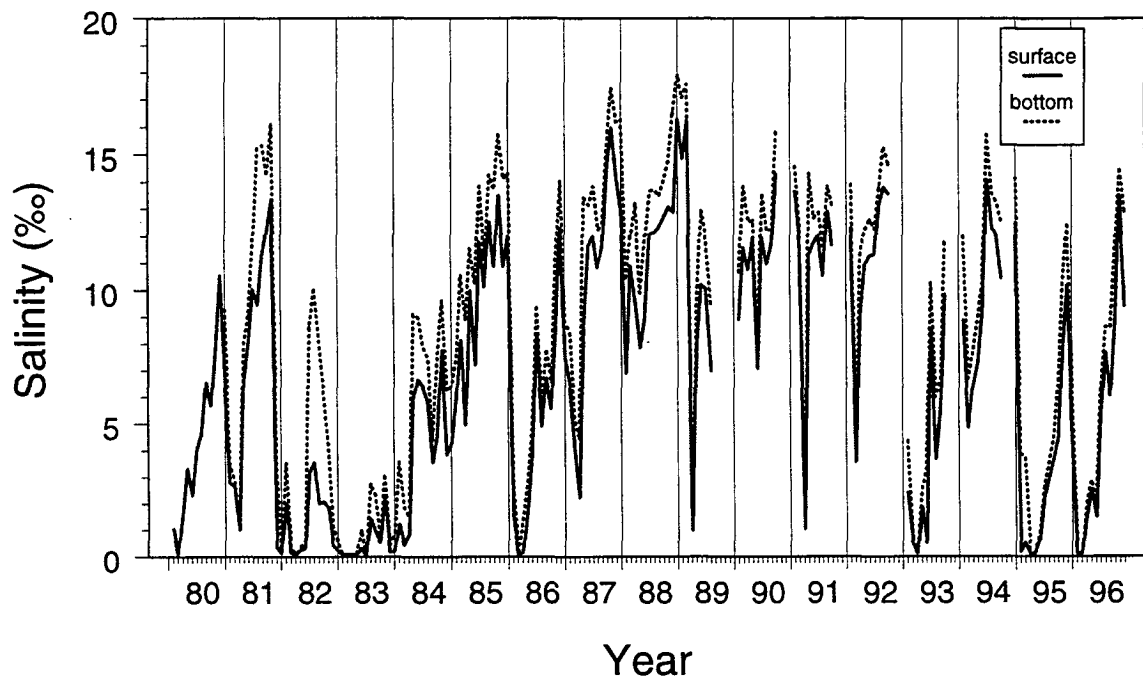


Figure 4 Monthly surface and bottom salinity in Suisun Bay from 1980 to 1996

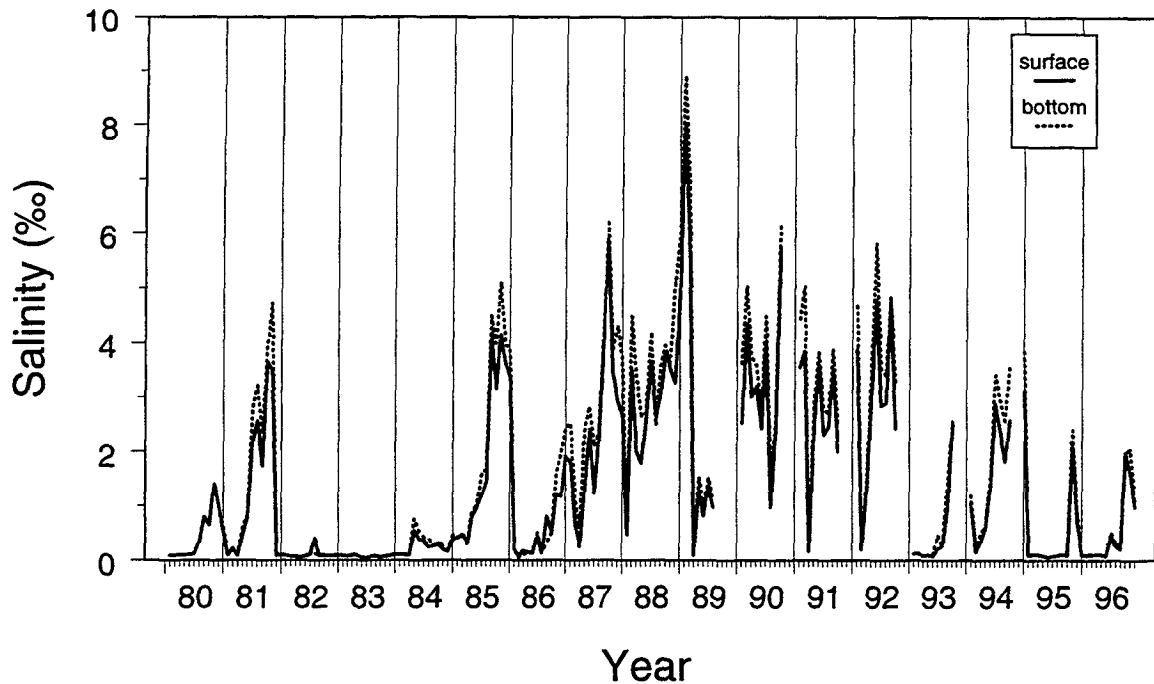


Figure 5 Monthly surface and bottom salinity in the west delta from 1980 to 1996

## Temperature

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Temperature was influenced by the moderating effect of the ocean, which kept summer temperatures down in areas where intrusion of oceanic water was high. The temperature range was greatest in the west delta (Figure 6), which had both the highest and lowest temperatures, always  $>20^{\circ}\text{C}$  in summer and as low as  $7$  to  $8^{\circ}\text{C}$  in winter. Suisun Bay temperatures were similar to those of the west delta except that summer temperatures were not quite as high (Figure 7). San Pablo Bay had a narrower temperature range than Suisun Bay and the west delta (Figure 8). Summer temperatures there were rarely  $>20^{\circ}\text{C}$ . Central Bay had the narrowest temperature range (Figure 9). Only in 1983, an El Niño year, did temperature there exceed  $20^{\circ}\text{C}$  and only rarely were temperatures  $<10^{\circ}\text{C}$ . But Central Bay showed more temperature stratification than any other region. South Bay was warmer in summer and cooler in winter than Central Bay, often  $>20^{\circ}\text{C}$ , and more often  $<10^{\circ}\text{C}$  in winter (Figure 10). Little or no temperature stratification occurred in South Bay.

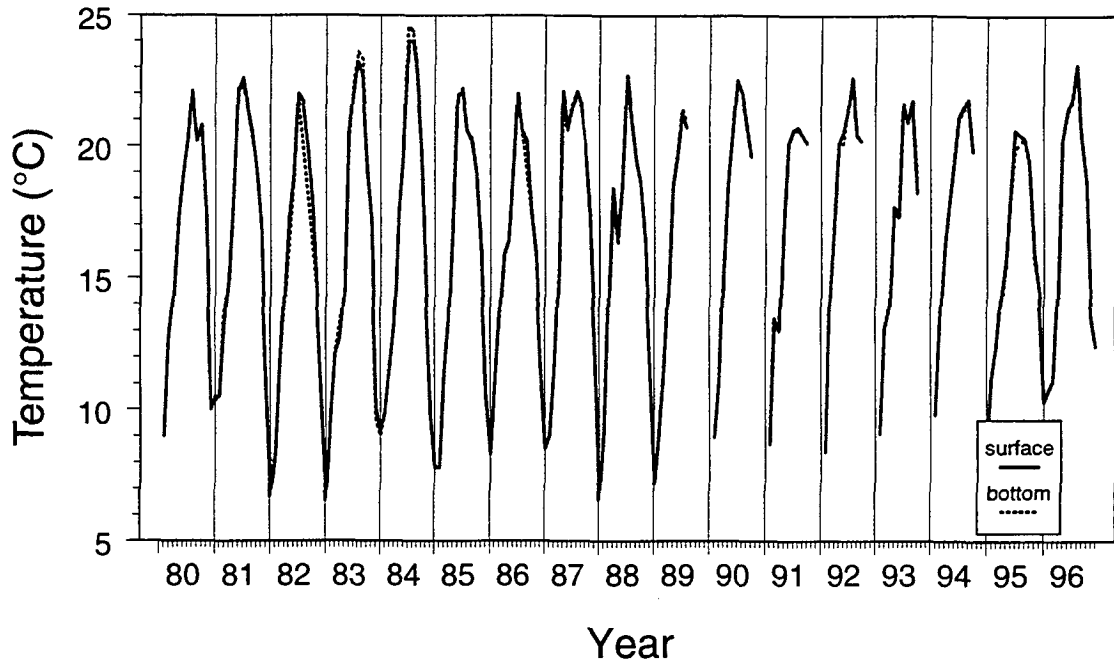


Figure 6 Monthly surface and bottom temperature in the west delta from 1980 to 1996

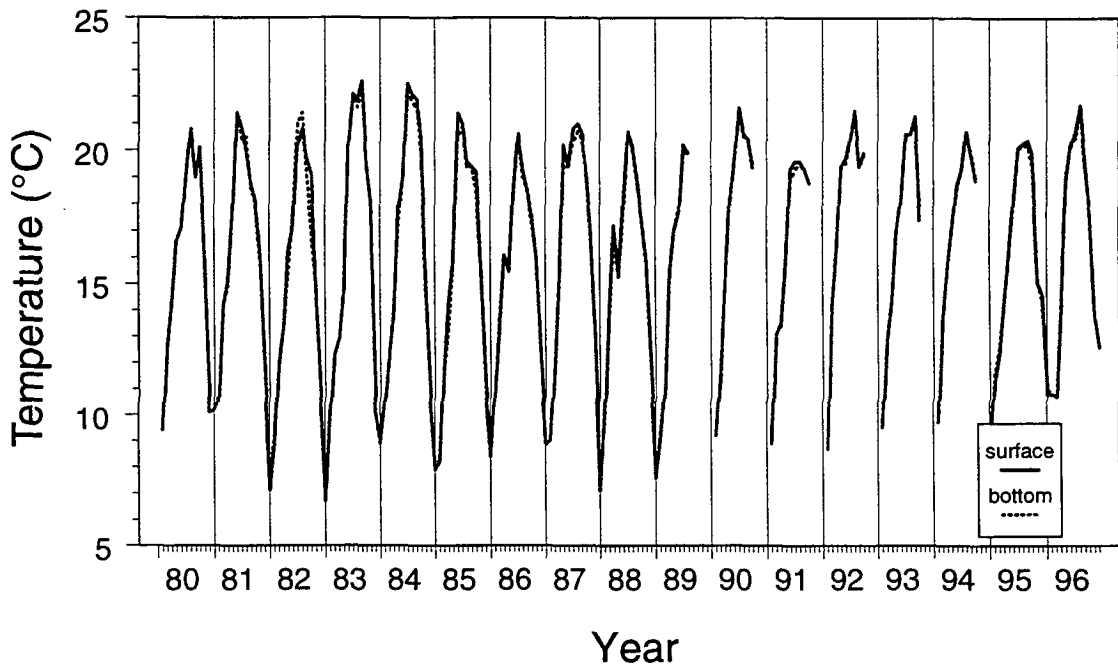


Figure 7 Monthly surface and bottom temperature in Suisun Bay from 1980 to 1996

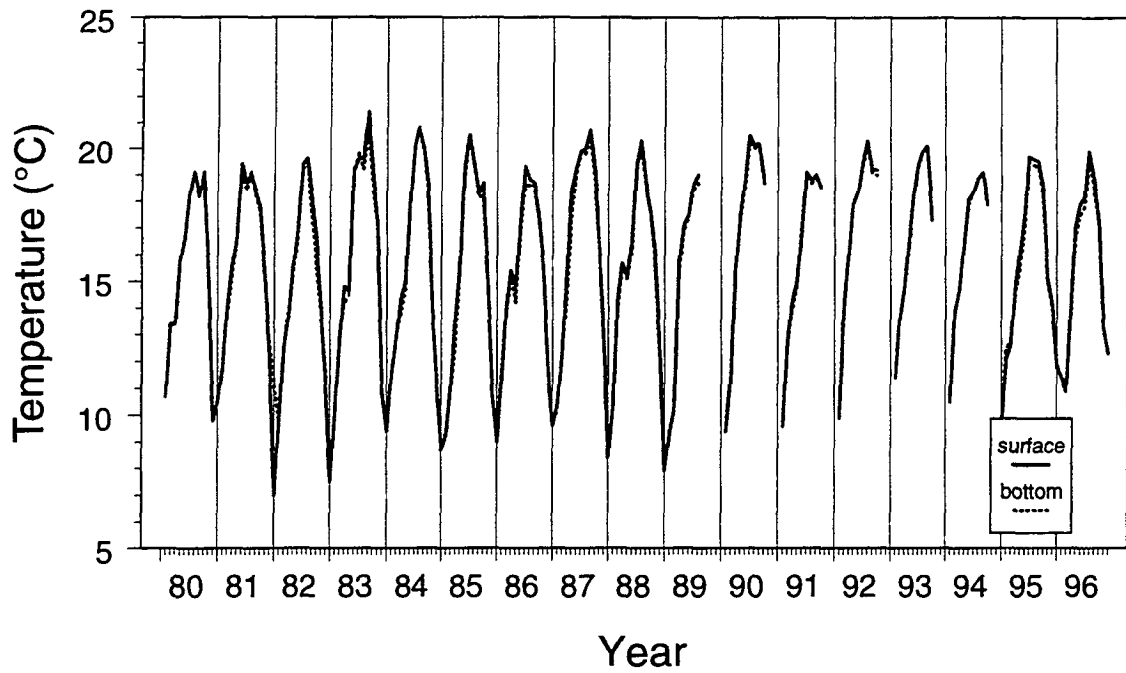


Figure 8 Monthly surface and bottom temperature in San Pablo Bay from 1980 to 1996

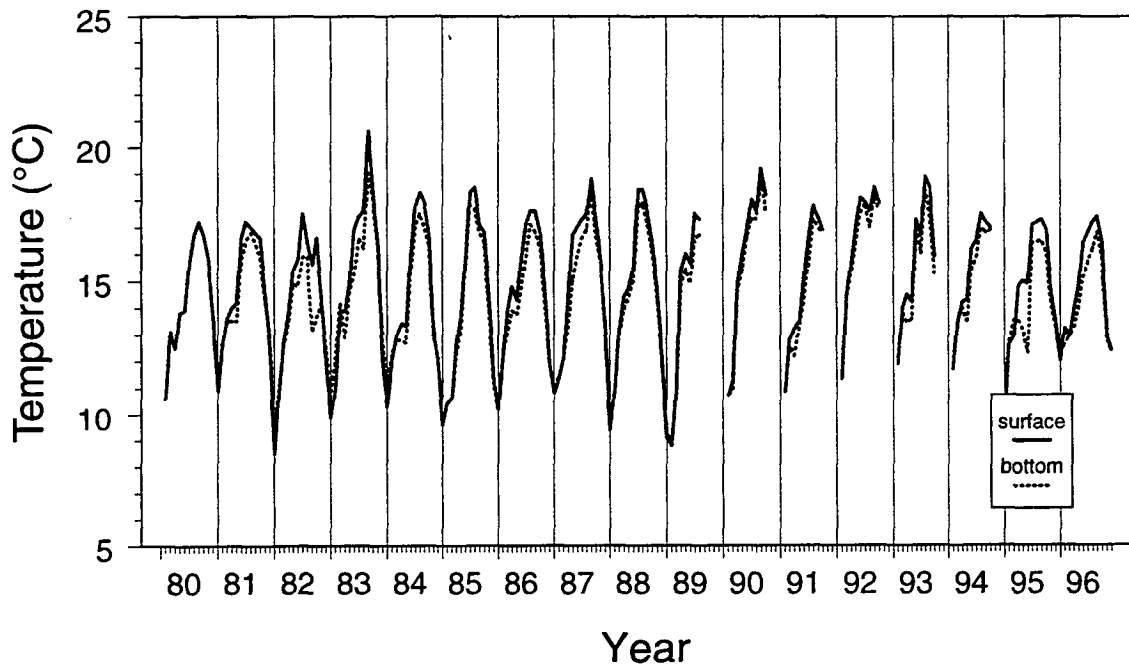
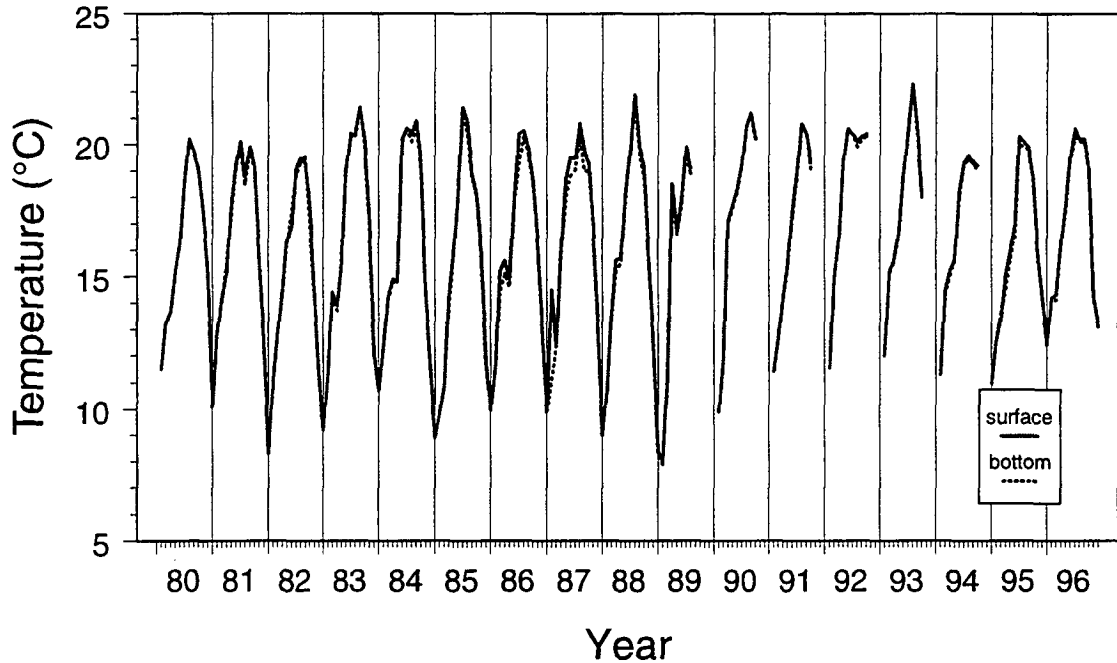


Figure 9 Monthly surface and bottom temperature in Central San Francisco Bay from 1980 to 1996



**Figure 10 Monthly surface and bottom temperature in South San Francisco Bay from 1980 to 1996**

A temperature record exists for the ocean at the Farallon Islands, 42 km west of the Golden Gate (Figure 11). Surface temperatures there ranged from 10 to 16.4 °C from 1980 to 1996. During the sampling period, temperatures tended to be warmer than the 72-year (1925–1996) mean. Warmer than average temperatures occurred during 1982–1983, 1986–1987, 1992–1993, and in 1995.

The Farallon Islands temperature record showed that the ocean was considerably colder than Central Bay except in December, January, and February (Figure 12). Average January temperatures were almost 2 °C warmer at the Farallon Islands than in Central Bay. In summer, however, Central Bay temperatures averaged as much as 4.5 °C higher than at the Farallons. Ocean temperature declined slightly in spring, whereas Central Bay temperature climbed sharply.

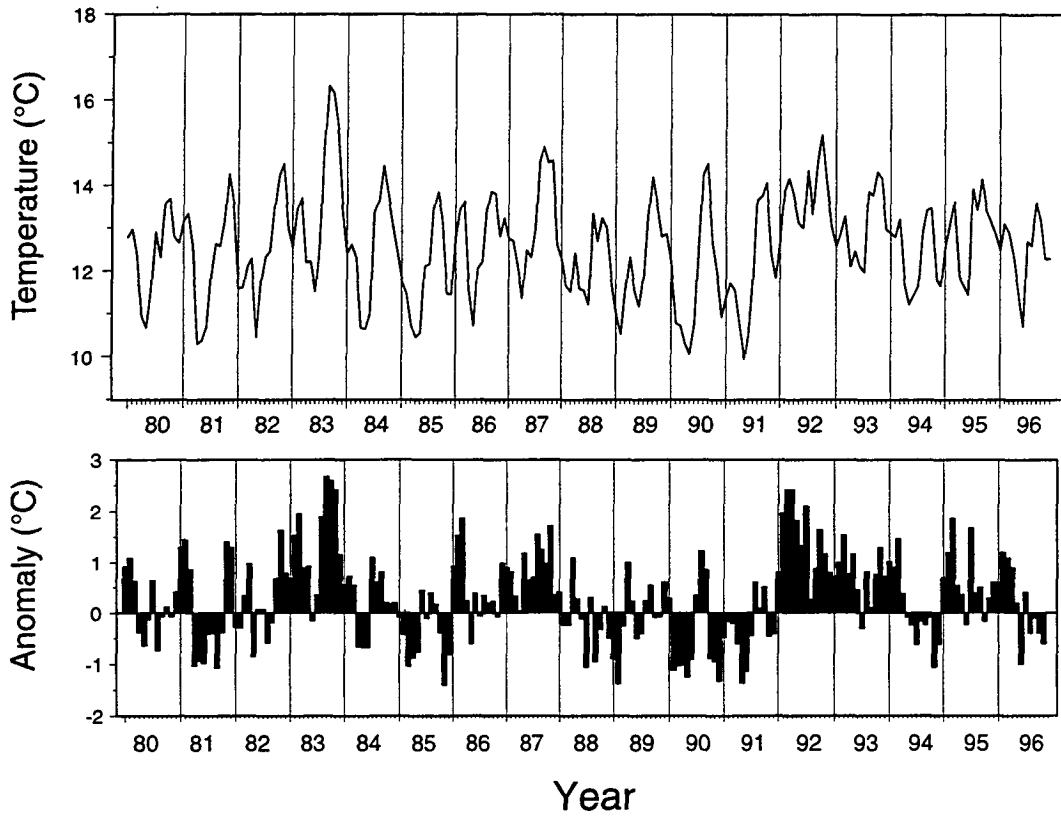


Figure 11 Mean monthly surface temperatures at the Farallon Islands from 1980 to 1996 (upper graph) and deviations from the 1925 to 1995 mean (lower graph)

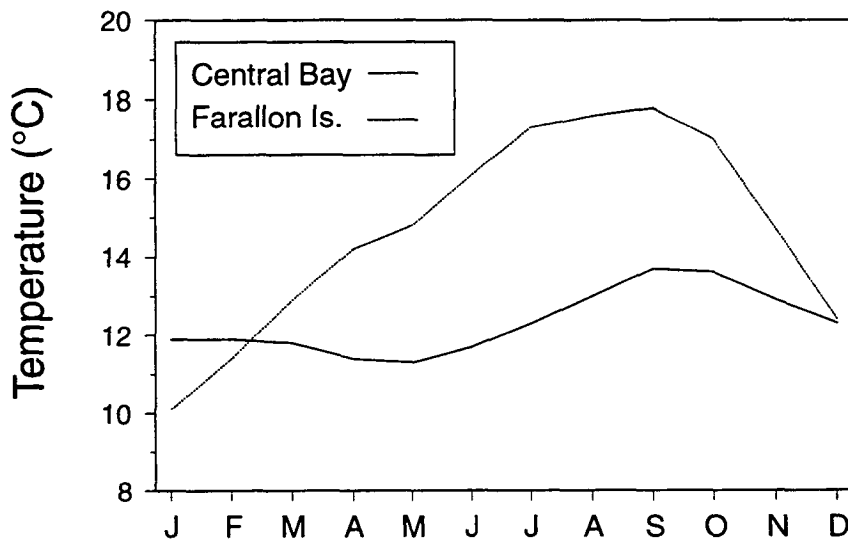


Figure 12 Average monthly surface temperatures (°C), at the Farallon Islands (1925 to 1996) and in Central San Francisco Bay (1980 to 1996)