Figure 3-5. The range of total coliform concentrations observed at different surface water locations in the Central Valley and Delta.

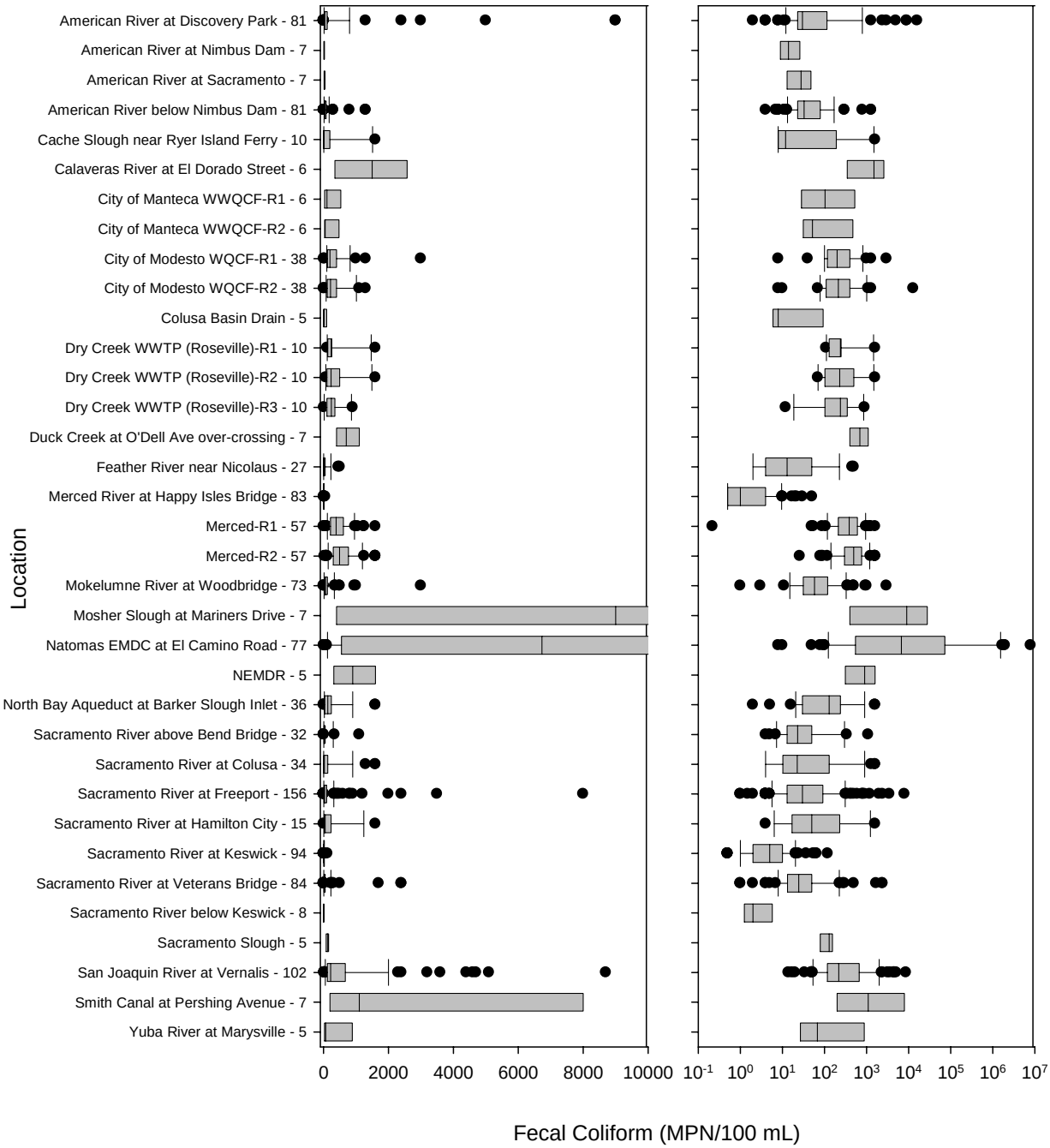

Figure 3-6. The range of fecal coliform concentrations observed at different surface water locations in the Central Valley and Delta.

Figure 3-7. The range of *E. coli* concentrations observed at different surface water locations in the Central Valley and Delta.

3.4 SPATIAL AND TEMPORAL TRENDS IN THE SACRAMENTO AND SAN JOAQUIN RIVER BASINS

A closer look at the fecal indicator data is provided in Figures 3-8 through 3-12, where concentrations are explored along the main stems of the Sacramento and San Joaquin Rivers.

For total coliforms, there is a clear increasing trend with distance downstream in the Sacramento River. For fecal coliforms, concentrations increased below Keswick and remain relatively constant downstream. Trends in *E. coli* concentration are not apparent because data are only available for the urban-impacted portion of the Sacramento River, and no data were available for upstream reaches. The spatial trends for total coliforms in the San Joaquin River are obscured by the fact that the higher level concentrations are capped at ~2400 MPN/100 ml. However, *E. coli* data in the San Joaquin River do show spatial variation over the distance of travel, with the highest concentrations not at the most downstream location but at an intermediate location near Hills Ferry. This trend is also visible in the map of the data shown in Figure 3-3.

In general, temporal trends are not very strong, however, the highest concentrations in the Sacramento River were observed during the wet months, with the generally lower values found in the July and August.

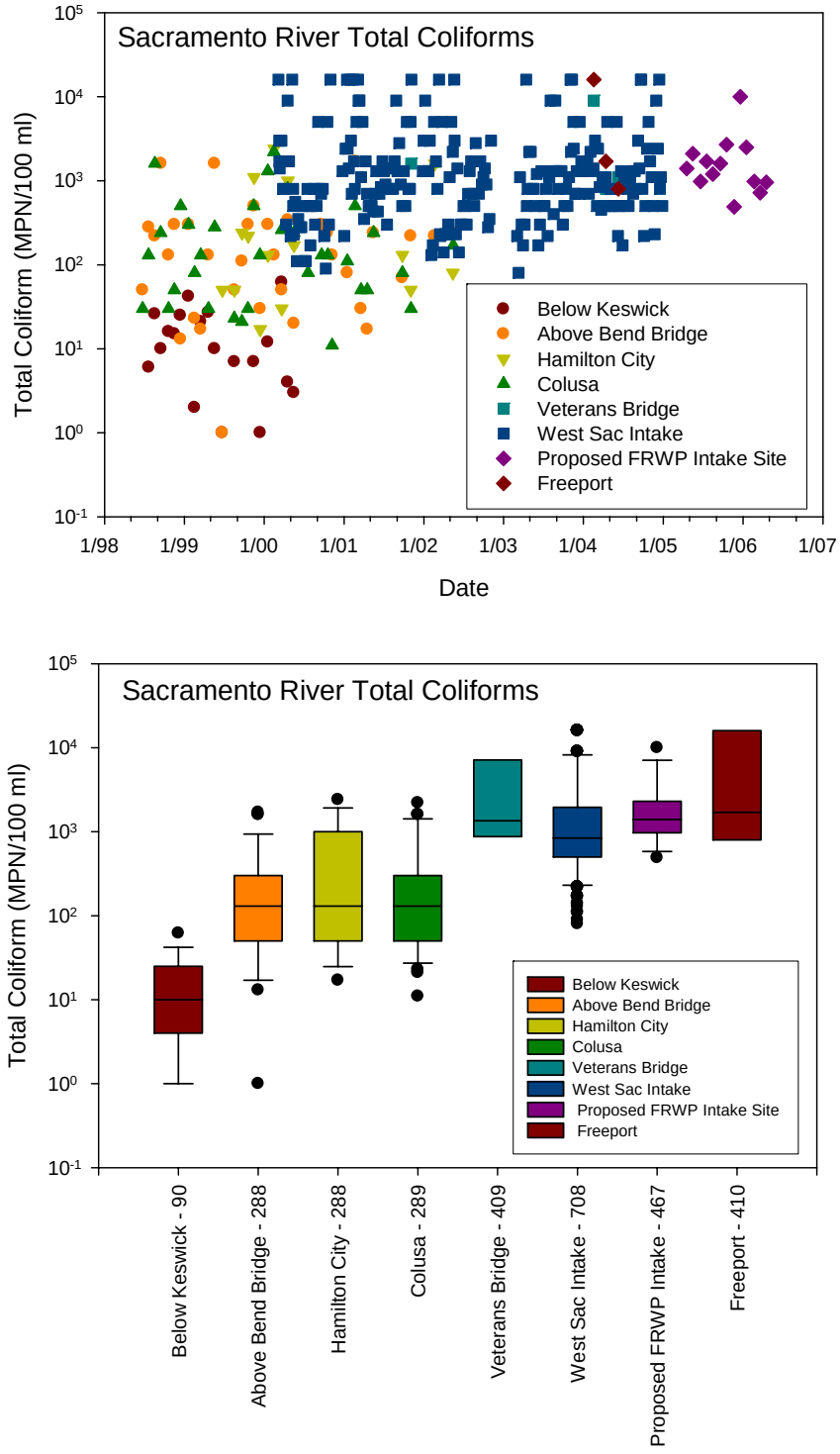

Figure 3-8. Total coliforms in the Sacramento River, as a function of time and location.

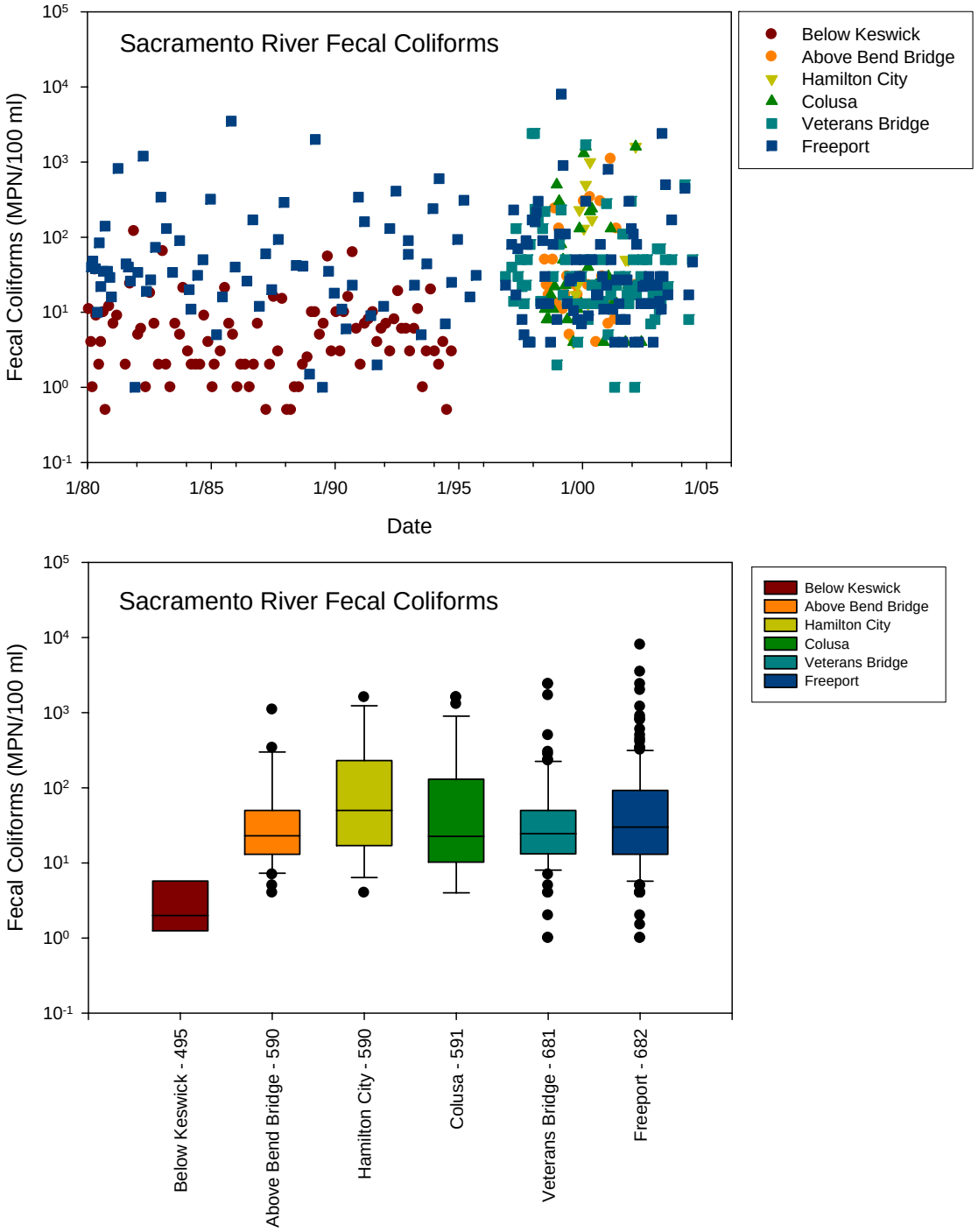

Figure 3-9. Fecal coliforms in the Sacramento River, as a function of time and location.

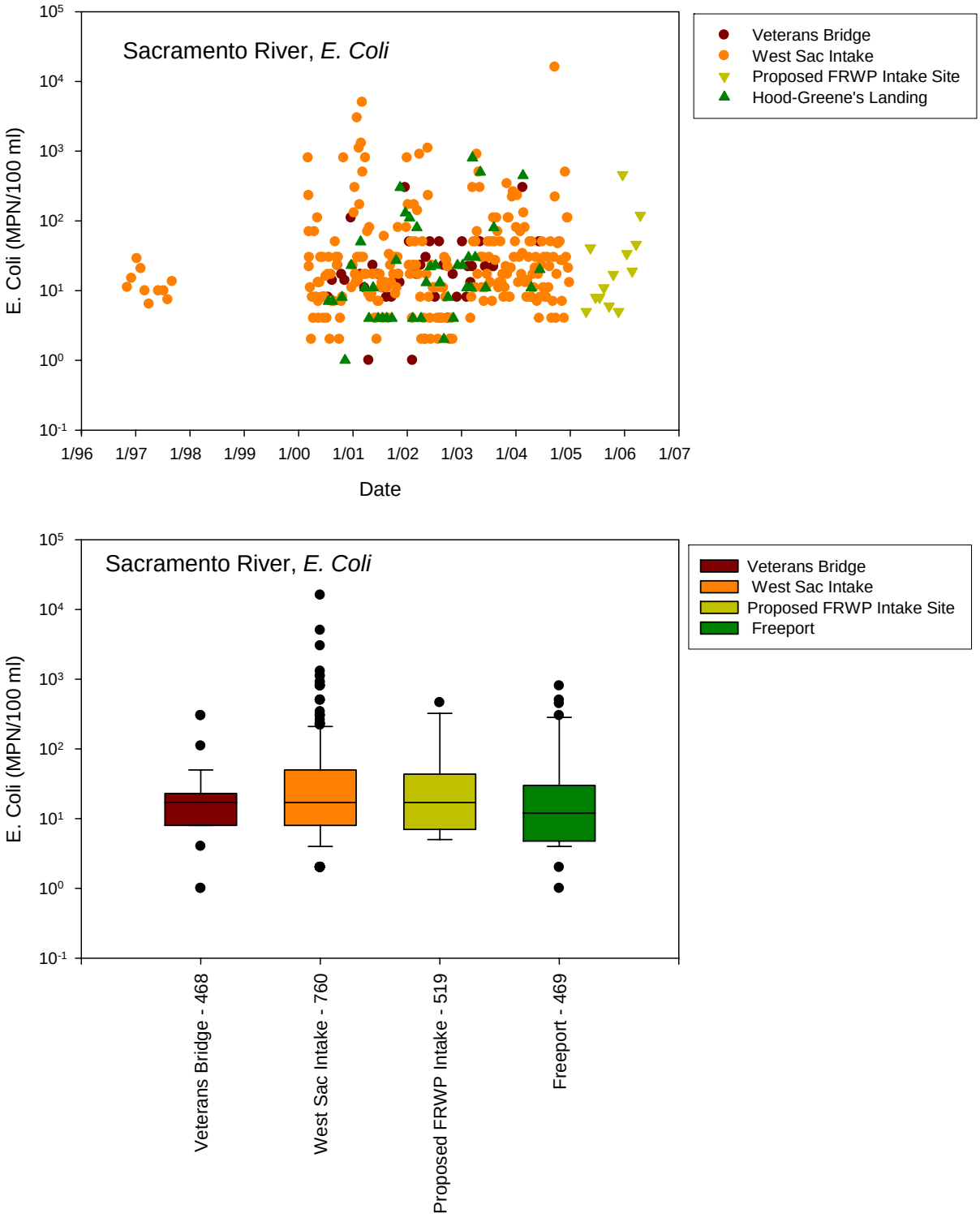

Figure 3-10. *E. coli* in the Sacramento River, as a function of time and location.

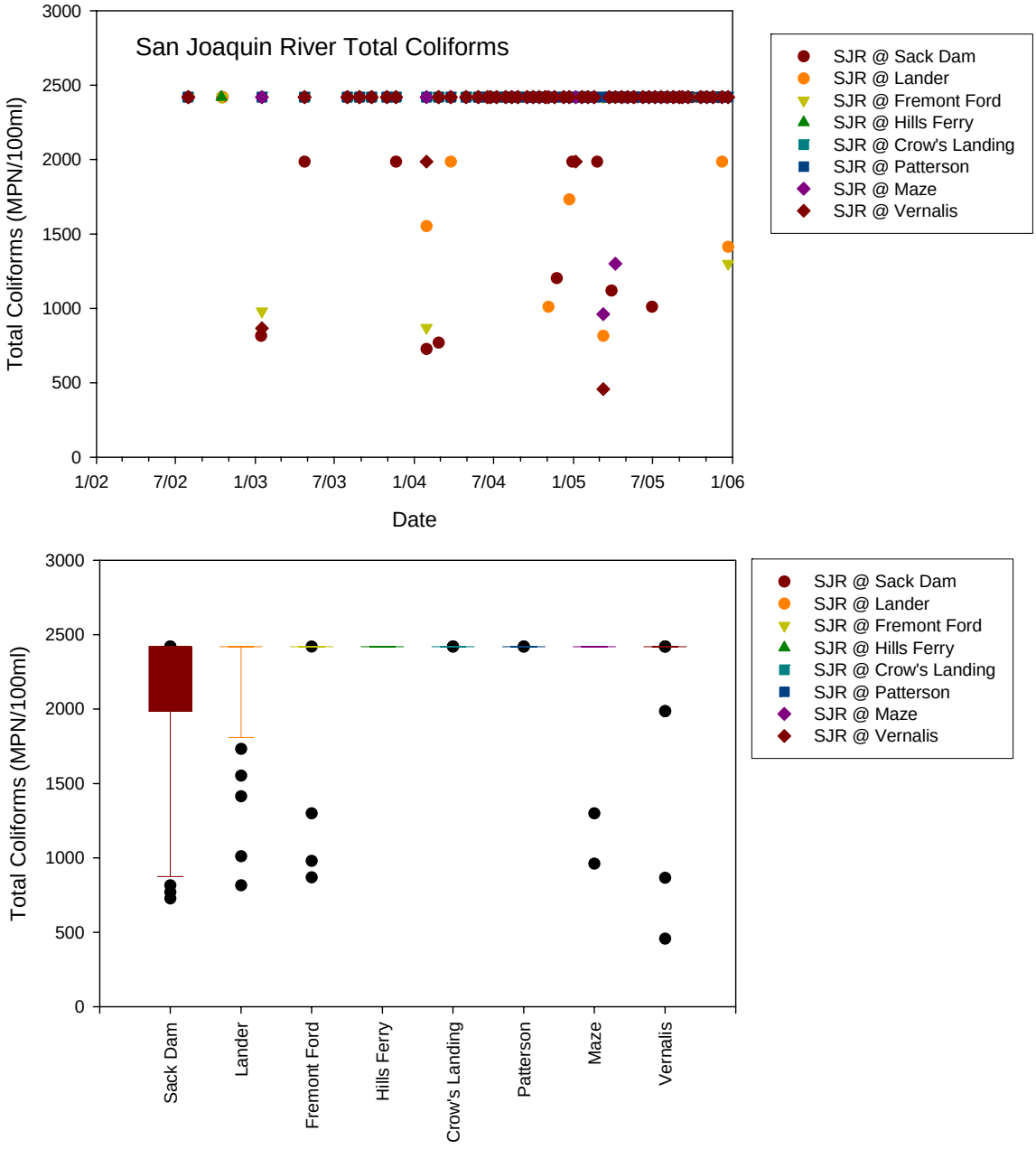

Figure 3-11. Total coliforms in the San Joaquin River, as a function of time and location.

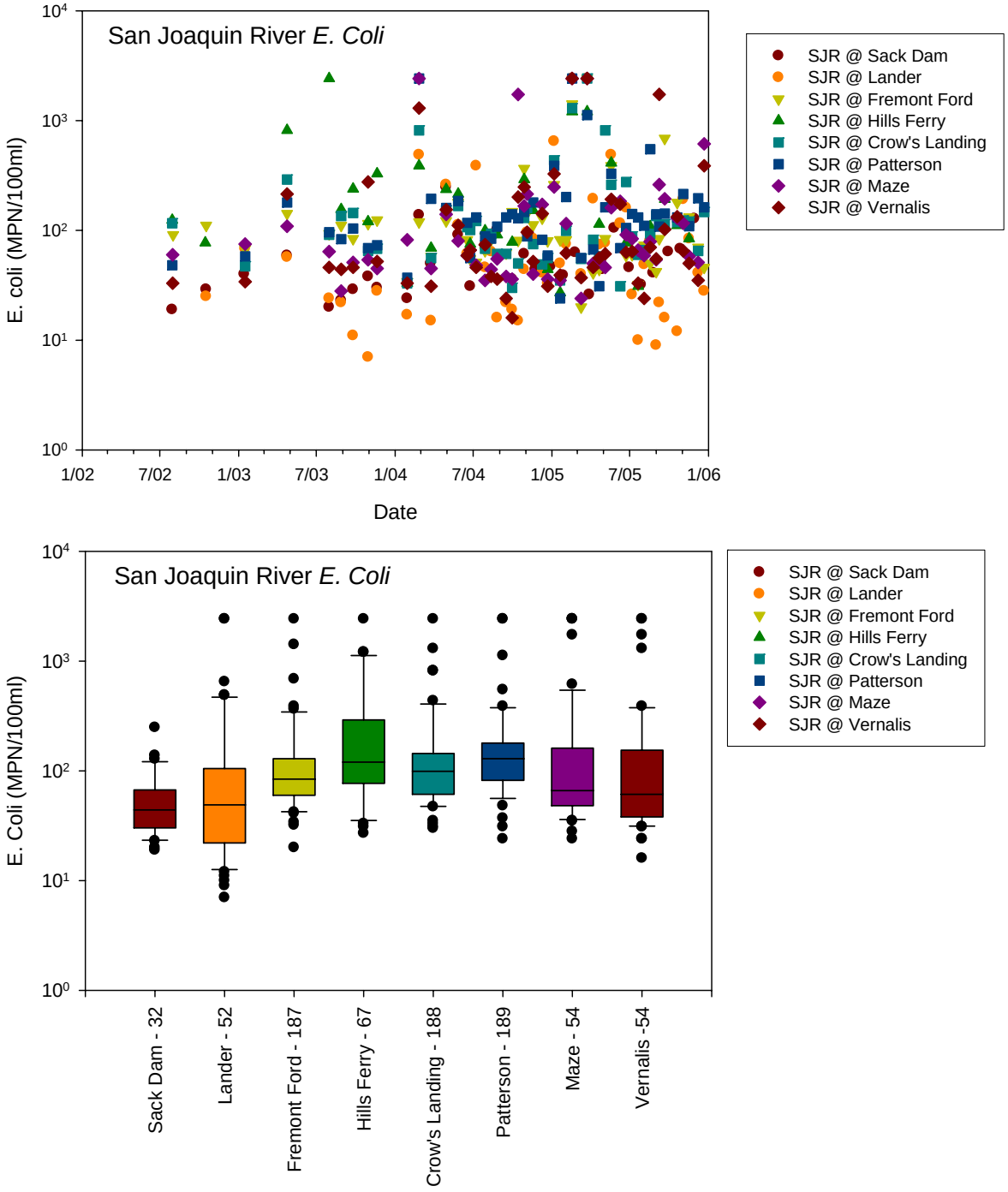

Figure 3-12. *E. coli* in the San Joaquin River, as a function of time and location.

3.5 COLIFORMS AND PATHOGENS IN TREATED WASTEWATER

Although raw sewage has very high concentrations of coliforms (potentially in excess of 10^6 MPN/100 ml), wastewater treatment is effective at removing and inactivating these bacteria through a variety of processes including solids separation and disinfection. Data from wastewater dischargers, shown in Figure 3-13 show relatively low concentrations of total coliforms, generally lower than what would be found in most surface waters. Median concentrations are generally 10 MPN/100 ml or lower for the wastewater plants for which data were available. Data on other coliform groups (fecal coliforms, *E. coli*) were not reported for wastewater samples in the database.

Although some wastewater treatment processes such as solids separation and disinfection using chlorine can be effective in removing the coliforms, low coliform concentrations in wastewater treatment effluents do not guarantee absence of pathogens. As a matter of fact, *Cryptosporidium* oocysts and *Giardia* cysts are resistant to chlorine disinfection and relatively high concentrations of *Cryptosporidium* and *Giardia* concentrations can be observed in wastewater treatment plant effluents. Available data from the Sacramento Regional Wastewater Treatment Plant (SRWTP) effluent for the period of January 1997 through August 2002 indicated relatively high concentrations of *Cryptosporidium* (in a range of 2-192 oocysts/ L) and *Giardia* (in a range of 0.08- 84 cysts/ L). Median and mean concentrations observed at the SRWTP effluent are 1.9 and 7.3 cysts/ L for *Cryptosporidium* and 39 and 44.7 oocysts/L for *Giardia*, respectively.

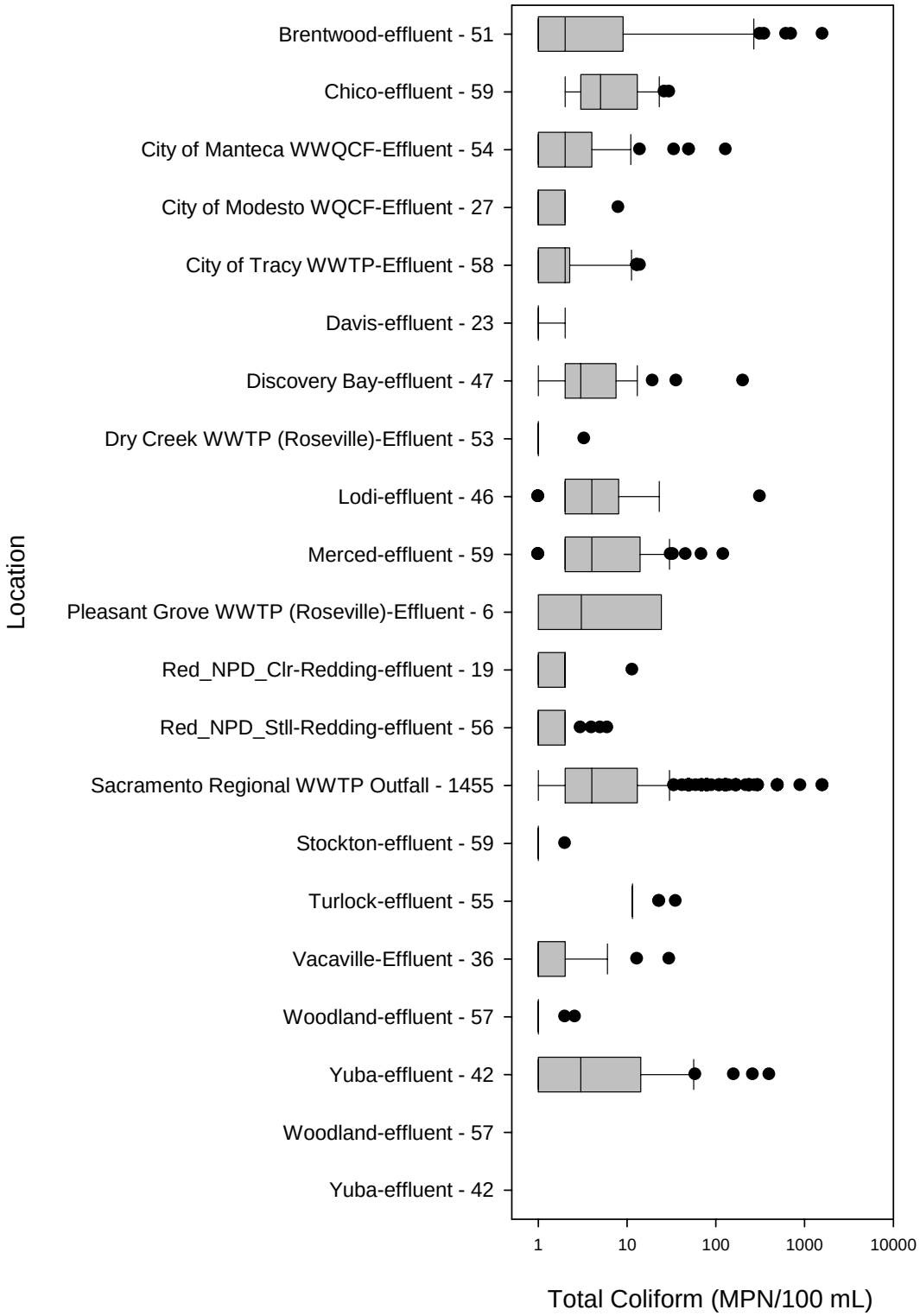

Figure 3-13. Total coliform concentrations in wastewater effluent samples from dischargers in the Central Valley and Delta.

3.6 COLIFORMS IN URBAN RUNOFF

Data on urban runoff concentrations were available for several locations from Sacramento and Stockton for total coliforms, fecal coliforms, and *E. coli*. Measurements were made separately for wet and dry conditions, although flow data were not available. Box plots summarizing these data are shown in Figures 3-14 through 3-16.

Urban runoff concentrations were found to be uniformly high, and higher than concentrations in surface water previously described in this chapter. For example, total coliform concentrations exhibit median concentrations in the vicinity of 10^5 MPN/100 ml during both wet and dry seasons. There was no consistent seasonal difference in concentration between the wet and dry seasons. Concentrations were about an order of magnitude lower for fecal coliforms and for *E. coli*, and with no systematic seasonal differences.

3.7 SUMMARY

The pathogen and indicator data in the database, compiled by the Central Valley Drinking Water Policy Workgroup, consisted primarily of measurements of total and fecal coliforms and *E. coli*. There was limited data on other species of coliforms, and even more limited data on pathogens such as *Cryptosporidium* and *Giardia*. Fecal indicator concentrations are highly variable both temporally spatially, and can vary by orders of magnitude. Despite this variability, the maps and plots of available data do provide a snapshot of the nature and dynamics of indicator concentrations across the Central Valley and Delta.

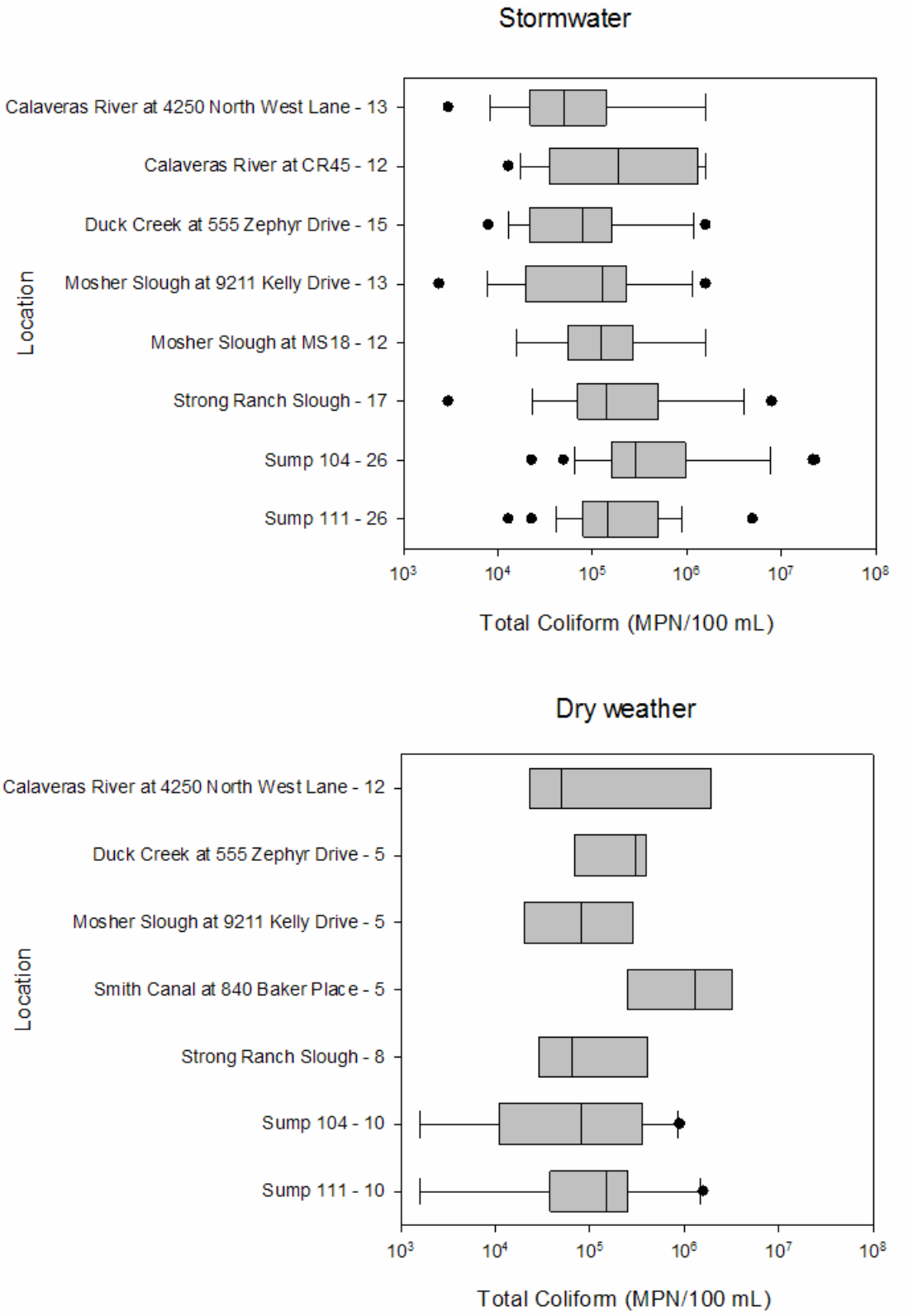

Figure 3-14. Total coliforms in stormwater at selected locations in the Central Valley and Delta, during wet weather and dry weather conditions.

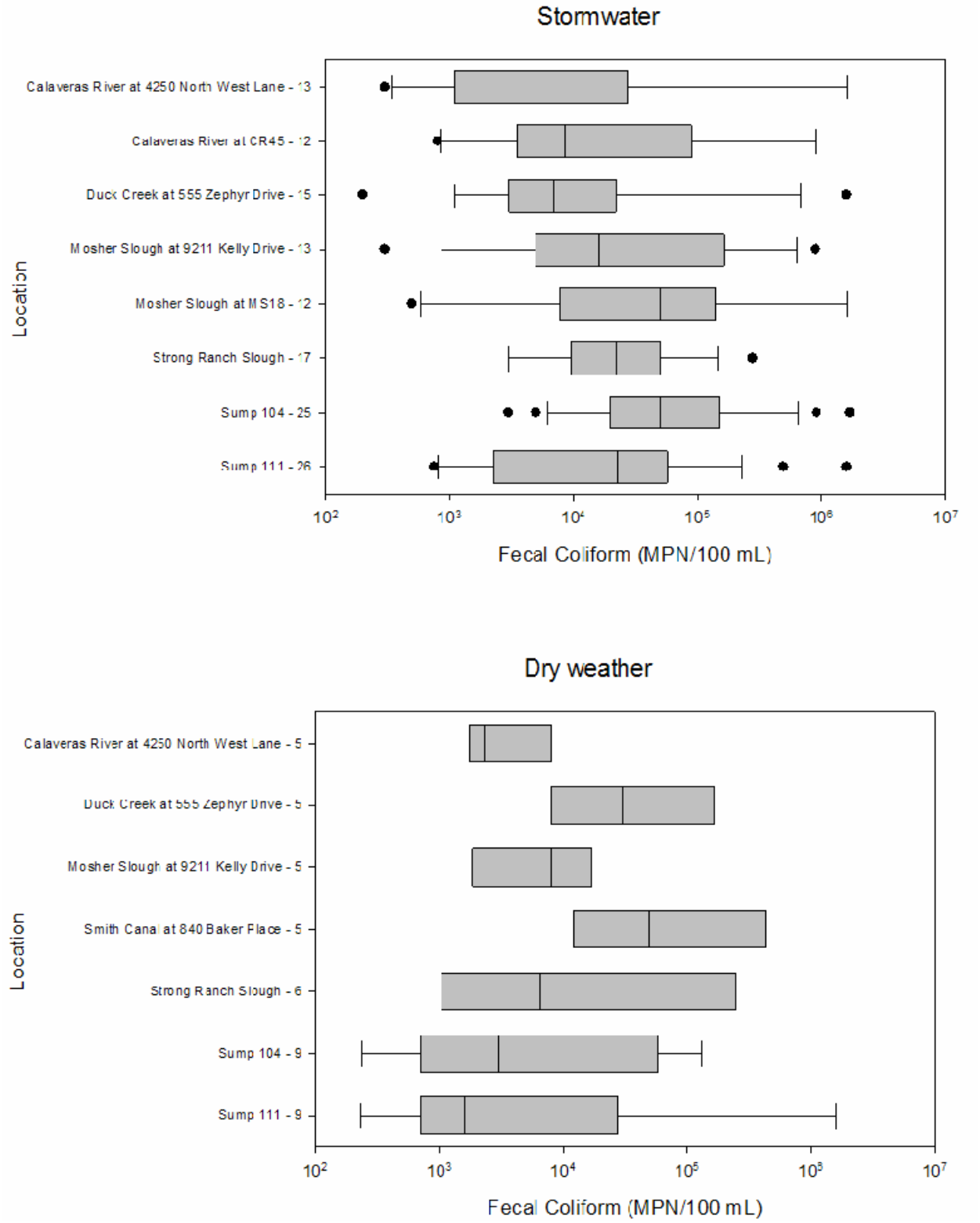

Figure 3-15. Fecal coliforms in stormwater at selected locations in the Central Valley and Delta, during wet weather and dry weather conditions.

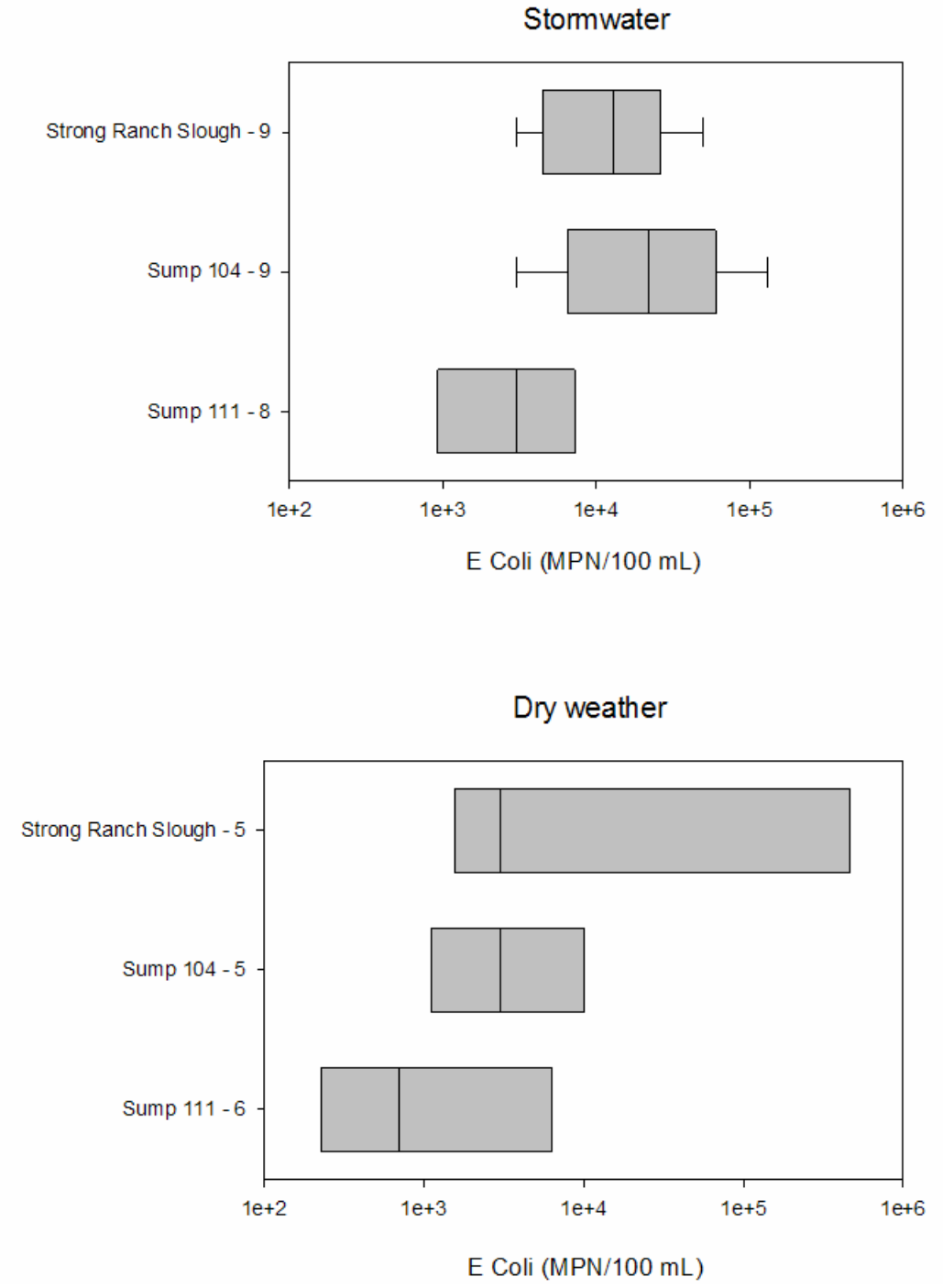

Figure 3-16. *E. Coli* in stormwater at selected locations in the Central Valley and Delta.