Fecal Indicator Bacteria (FIB) Levels During Dry Weather from Southern California Reference Streams

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Summary

Annual mean concentrations (both single sample and 30-day geometric mean) were below established water quality criteria for all three bacteria indicators. Approximately 1.5%, 14%, and 3% of E. coli, enterococci, and total coliforms, respectively, from the natural sites exceeded single sample water quality criteria.

Dry weather FIB in natural streams are typically two orders of magnitude lower than those observed in streams draining developed watersheds.

Minor perturbations (i.e. agricultural and transportation runoff, and recent fires) can cause streams to move away from “unimpacted” conditions.

Dry weather FIB levels were one to two orders of magnitude lower than those observed in natural streams during storm conditions.

Fecal indicator bacteria levels exhibit seasonal patterns. Mean bacteria levels and frequency of exceedance of water quality standards were higher during the warmer summer months (June-August) for all three FIB.

Median annual FIB densities were higher in non-perennial than in perennial streams mainly due to high levels in the period immediately prior to streams drying up; but ranges generally overlapped (p > 0.05).

Accounting for natural background levels will allow for management targets that are more reflective of the contributions from natural sources.

Key Research Questions (7):
1. What are the “background” ranges of concentrations of FIB associated with dry weather flow from reference areas?
2. What is the frequency with which reference FIB levels exceed relevant water quality standards?
3. How do the ranges of FIB concentrations associated with reference areas compare with those associated with urban (developed) areas?
4. How does seasonality influence stream FIB levels associated with reference areas?
5. How do the background ranges of FIB concentrations associated with reference areas change as annual temperatures increase?
6. How do the background ranges of FIB concentrations associated with reference areas change as annual precipitation decreases?
7. How do the background ranges of FIB concentrations associated with reference areas change as the extent of urban development increases?

Background FIB Levels

Nearly 82% of the time, samples did not exceed daily bacterial thresholds (Fig. 2). E. coli had the lowest daily percent exceedance (1.5%). A total of 13.7% of enterococci exceeded daily thresholds. The average enterococci level of these exceedences was 202 MPN/100 ml.

Natural streams were significantly lower than other streams (p < 0.001). Minor perturbation streams were significantly lower than developed Ballona Creek (p < 0.001).

Natural streams' mean Enterococci concentrations were significantly lower than all other streams (p < 0.001) (Fig 5).

Natural streams during dry weather had the lowest daily percent exceedance (1.5%)

Natural streams had the lowest mean concentration of E. coli (98.5% < 235 MPN/100 ml).

Natural streams had the lowest mean concentration of enterococci (151.5% < 235 MPN/100 ml).

Natural streams had the lowest mean concentration of total coliforms (151.5% < 235 MPN/100 ml).

Southern CA Reference Streams (Fig. 8)

Figure 4. Cucamonga Creek, San Bernardino, CA; a natural site (a); and developed Ballona Creek (b), Los Angeles, CA.

Figure 5. Distribution of E. coli, enterococci, and total coliforms in natural streams and streams with minor perturbations, and in developed Ballona Creek watershed in southern California, USA.

Figure 6. Mean monthly temperature (°C) and dissolved oxygen (mg/l) comparison (a) and gross mean total coliform densities in natural streams in northern CA (b) between May 1996 and May 2007. The solid line indicates the 30-day geometric mean for total coliforms equal to 1,000 MPN/100 ml. All points above the line represent bacteria water quality exceedances.

Temperature explained about one-half the variation in total coliforms density suggesting that stream temperatures regulated bacterial populations (Fig. 6a).

Summer months (June to August) were significantly higher than all other seasons (p < 0.01) (Fig. 6b).

References

