Practical methods to find polluted areas in urban stormwater catchments to support management actions

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Introduction:

San Francisco Bay is polluted with polychlorinated biphenyls (PCBs).

Many sites have been characterized for PCBs concentrations during storms (Fig. 1), but management prioritization is hampered by variations in the storms sampled and proportions of cleaner versus dirtier land uses among the watersheds, and upstream sources are hard to identify. These challenges are addressed in these new methods.

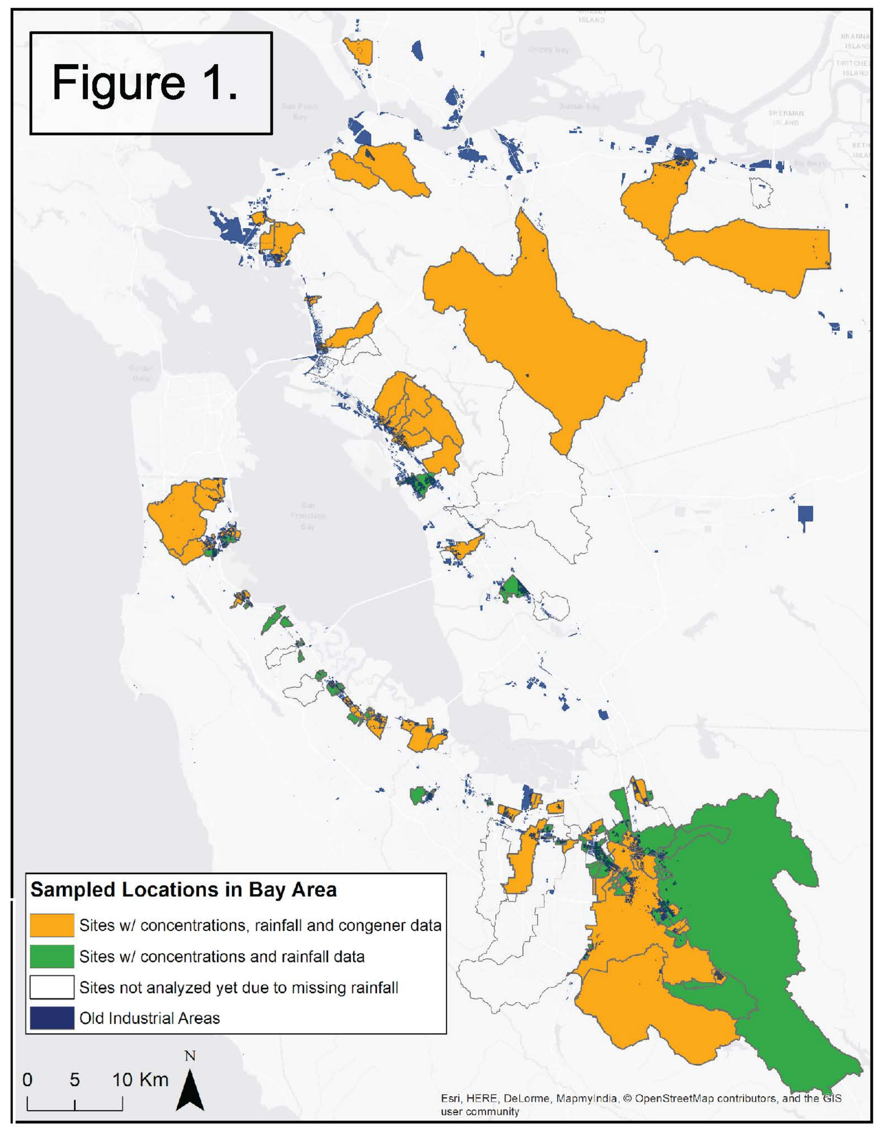

Figure 1.

Approach - Method 1: Loads and yields:

Storm PCBs load was estimated from measured concentration combined with rainfall and a modeled runoff estimate. To account for variation in sizes of sampled storms among sites, the storm load was adjusted to a standard storm size using a relationship between storm size and load based on data from watersheds sampled during multiple storms.

To compare PCBs source areas among watersheds, yields were estimated by dividing standard storm loads by the area of land uses most likely to contain public and private properties with PCBs. Ranked by concentrations on suspended sediment, Figure 2 compares those with ranks based on concentrations in water and yields. Some watersheds with lower PCBs concentrations on suspended sediment or in stormwater have higher than average yields from source areas.

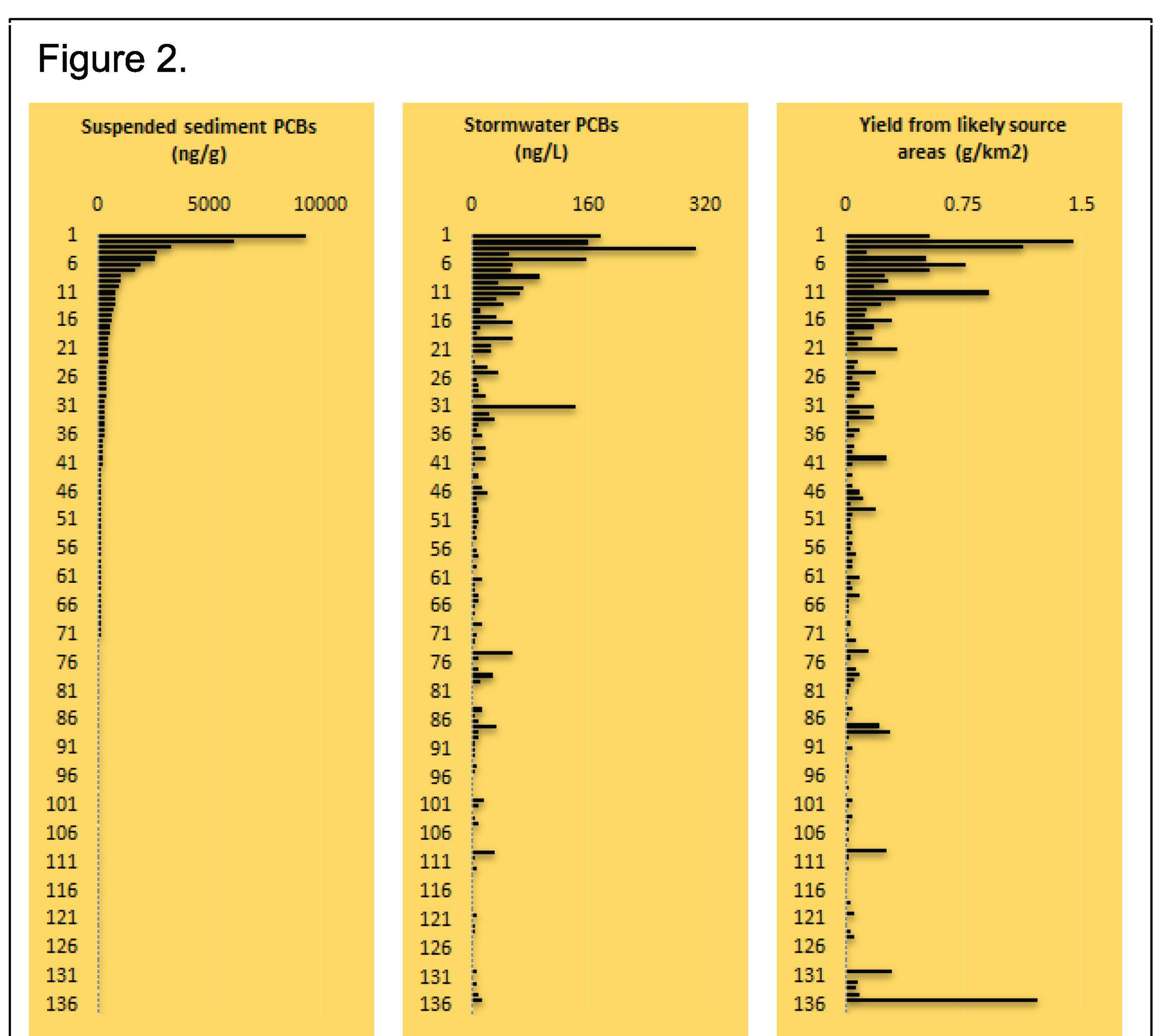

Figure 2.

Approach - Method 2: Aroclors

Commercial mixtures of PCBs were sold in the United States using the trade name Aroclor, with different common uses (Table 1). Unique or strong Aroclor fingerprints can suggest one or multiple sources and point to potential locations in the watershed based on historic uses.

Selected congeners were used to fingerprint samples:
a) Aroclor 1242: PCBs 18, 28, 31, 33;
b) Aroclor 1248: PCBs 44, 49, 66, 70;
c) Aroclor 1254: PCBs 87, 101, 110, 118; and
d) Aroclor 1260: PCBs 149, 170, 180, 187.

For each water sample, an index was computed as the sum of the percent contributions for each congener set. The index was then standardized for each Aroclor as a % of the sum of the four indices and binned (> 40% of the sum of Aroclor indices = a primary contributor; 20-40% = a secondary; < 20% = a minor contributor).

Table 1. Total US usage (1930s-1970s) (X=Major (X >20,000 metric t) and o=Minor)	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260
Capacitors (large, small, light ballasts)	X		o	
Transformers	o		X	X
Caulk and joint sealants			X	
Hydraulic fluids and other lubricants	X	X	X	X
Heat transfer fluids and systems	o	o	o	
Carbonless copy paper	o			
Wire and cable coatings			o	o
Vacuum pumps		o	o	
Cutting oils			o	
Coatings (e.g. Paints, varnishes, lacquers)	o	o	o	o
Adhesives	o	o	o	
Insulation and other building materials			o	

Results:

Stormwater programs are using data on PCBs in stormwater to identify catchments that potentially contain PCBs sources and thus may require management actions to reduce loads from these areas. To identify areas requiring source investigations, current methods apply thresholds based on the top 15th percentile of the regional stormwater data set (≥ 0.5 mg/kg for PCBs on suspended sediment; > 35 ng/L for PCBs water concentrations). On Figure 3, the blue circles show PCBs concentrations on suspended sediment ordered by rank (highest on the left) during 137 storm events across Bay Area watersheds. The orange triangles highlight sites with high yields (top 15th percentile). These data show most sites with elevated concentrations also had elevated yields, and no opportunities were missed to prioritize these catchments for source investigations. But some sites with moderate or even low PCBs concentrations have high yields and may have sources that would have been missed based on the concentration thresholds alone. Figure 4 shows a site-specific example of how we can use the new methods to inform management. At this site, stormwater samples collected downstream of a former caulk manufacturer have high PCBs concentrations and the catchment has high PCBs yield, indicating a source (Figure 4). Congener data show Aroclor 1254 is the primary Aroclor in the sample. Caulk was a major use of Aroclor 1254 (Table 1). This result points to the former caulk manufacturer as a likely source that should be investigated further.

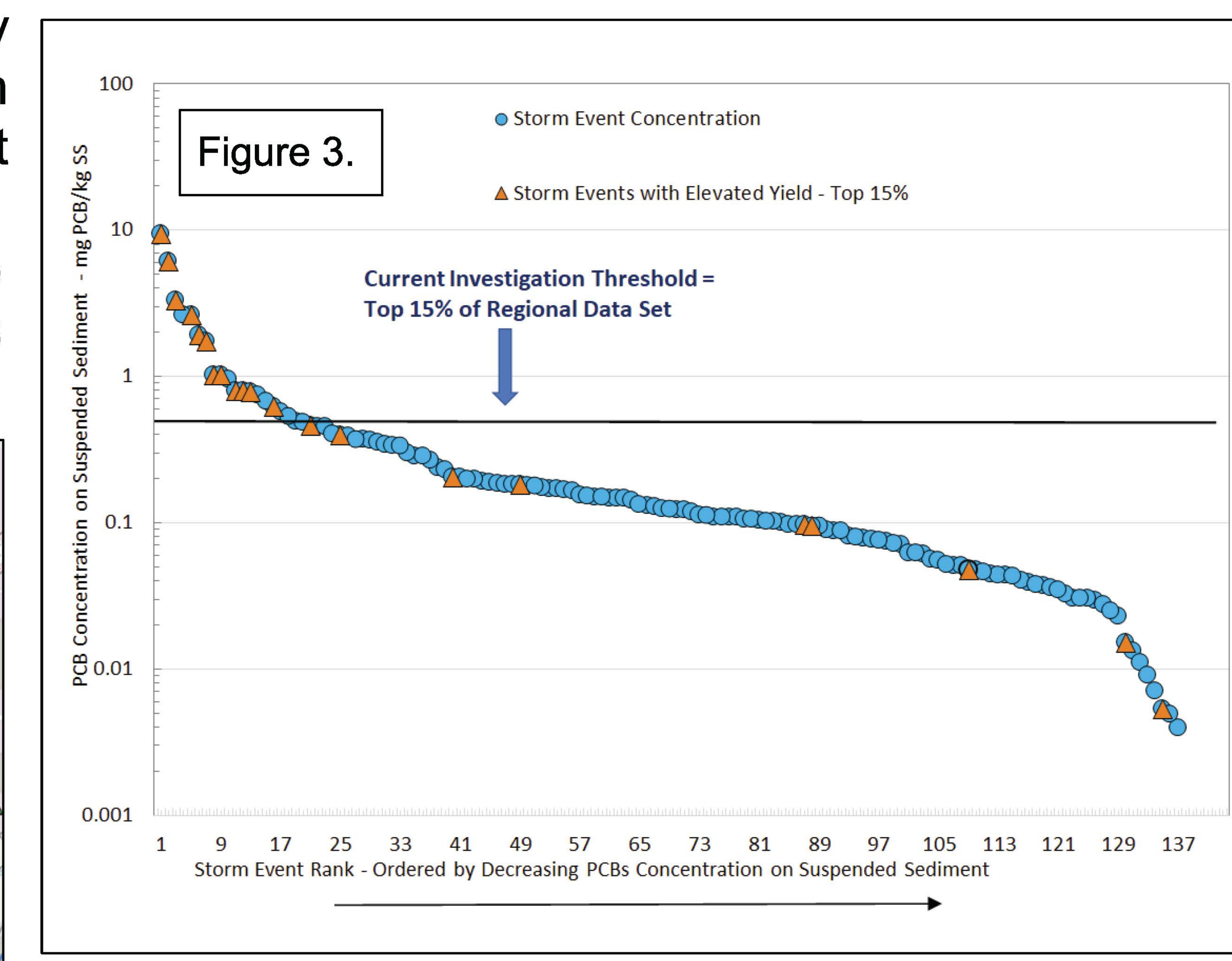

Figure 3.

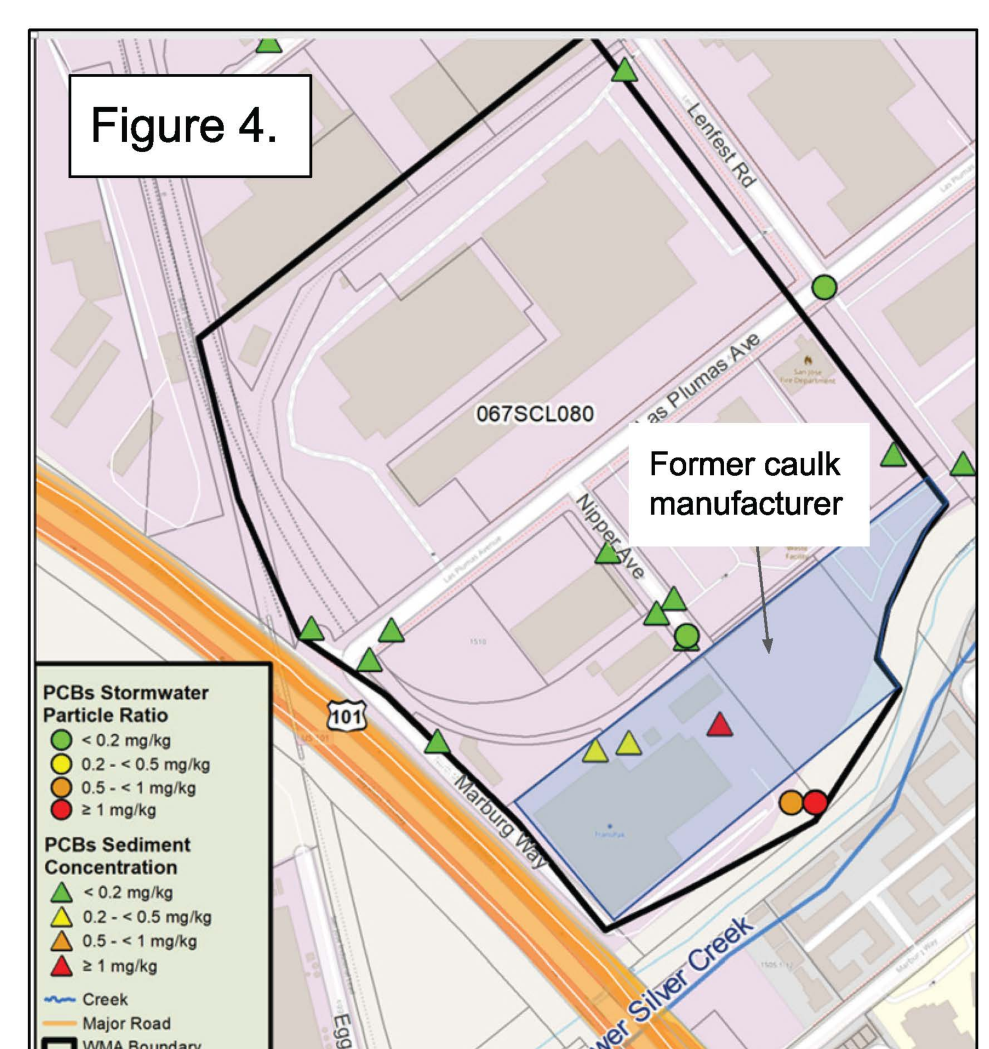

Figure 4.

Conclusion:

Two new methods for stormwater data analysis have been developed to support management decisions. These methods could be applied elsewhere for PCBs and other pollutants. The details of the methods and how to apply them are found in the references listed below.

References

McKee, L.J., Gilbreath, A.N., Hunt, J.A., Wu, J., Yee, D., and Davis, J.A., 2019. Loads and yields-based prioritization methodology pilot study. SFEI Contribution No. 817. San Francisco Estuary Institute, Richmond, California. https://www.sfei.org/documents/small-tributaries-pollutants-concern-reconnaissance-monitoring-loads-and-yields-based

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