Polychlorinated biphenyls in tree bark in Crystal Springs, Mississippi

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We collected tree bark samples from a total of 37 trees during early and mid-March 2003 from areas around the Kuhlman Electric Corporation property in Crystal Springs, MS. The purpose of this collection was to determine if the atmosphere has been a pathway for polychlorinated biphenyls (PCB) to reach residential and other properties in Crystal Springs. PCB congeners have high and variable vapor pressures, allowing them to evaporate from soils and other sources into the atmosphere (Hermanson & Hites, 1989). Once in the atmosphere in the gas phase, they can sorb into lipid tissues of animals and plants, including lipids found in the bark of trees (Hermanson & Hites, 1990). In this way, trees act as long-term passive air samplers located in one place. The amount of PCB found in tree bark is an indication of a tree's level of atmospheric PCB exposure at the site during its lifetime.

A total of 26 samples were analyzed for PCB for this report. Those not sampled were older trees or considered to be duplicates at a site. In order to determine the consistency of PCB congener distributions in the trees we analyzed duplicate samples at four sites

Samples were collected from residential properties surrounding the Kuhlman plant site, the floodplain area northwest from the Kuhlman site, the former "ice house" site directly across Fuhlgam Ave. to the north from the Kuhlman property, and Crystal Springs High School (Table I, figure 1; note: Table and Figures follow the end of text). Of the 26 samples analyzed for PCB, two of them had surrogate standard recoveries <50% resulting from analytical difficulties and are not considered to be quantitative representations of the sites (CS-2 and CS-19). However, they are included in the qualitative congener profile discussion.

Total PCB Concentrations: maximum and minimum

Total PCB in samples analyzed here is the sum of 103 PCB congeners represented by 75 chromatographic peaks. The method of quantifying these PCB congeners was developed at the EPA Large Lakes Research Station in Grosse Ile, MI (Mullin, 1985). The maximum total PCB concentration, 18,791 ng g^{-1} lipid was observed in sample CS-16, a 26 year old tree in the floodplain area west from McPherson Street and north from Forrest St., about 0.35 mile NNW from the NW corner of the Kuhlman plant site (figure 2). The second highest, 11,629 ng g^{-1} lipid, was sample CS-3, a 13 year old tree growing between chain-link fences in the back yard of a residential property at 403 Jackson St, immediately adjacent to the Kuhlman property. The third highest, 9393 ng g^{-1} lipid, was CS-12, another floodplain tree, 15 years old, growing partly in the stream flowing along Forrest St. that drains the Kuhlman plant site and areas directly north from it. The tree was growing at flag PT 1095. The least concentrated of these three samples is nearly double the concentration of the fourth most concentrated tree of the 26 analyzed here. Each of these samples shows that atmospheric PCB exposures at the Kuhlman site and in soils periodically flooded by drainage from that site were high. Each of these three most concentrated trees began growing and accumulating PCB from the atmosphere after 1976, about the time that PCB were banned and four years after Kuhlman Electric Company had been informed by the Monsanto Company – the manufacturer of PCB in the U. S. - that PCB were considered to be persistent compounds and should not be released into the environment.

The lowest concentration observed, 143 ng g^{-1} lipid, was tree CS-26, collected at 105 Tucker St. This tree, and those collected at 103 Tucker St. (CS-27) and at 302 McPherson St. (CS-28) were all up hill from the floodplain, and are the three least concentrated samples. While these trees are out of the floodplain and away from the immediate influence of PCB evaporating from floodplain soils, they apparently are still influenced by that source. The high PCB concentrations in floodplain trees show that floodplain soils have been an atmospheric source of PCB to the general area northwest from the Kuhlman facility during the lifetimes of these trees: the last 18 years from the 2002 growing season, or since 1984.

It is apparent from percent lipid data (figure 3) that trees CS-26, CS-27 and CS-28 have among the highest lipid contents of all trees reported here, which would reduce their lipid PCB amounts relative to other trees. However, the total mass of PCB in these trees, without normalization to lipid mass in the tree, is also among the lower of the 26 samples discussed here.

Total PCB trends in other samples

The highest residential bark sample observed was collected at 403 Jackson St., an area where PCB in soils on the adjoining Kuhlman property varies by a factor of about 10 over a distance of about 40 feet. (see Horshak, 2003). This level of variability could explain the factor of 3.7 difference in total PCB values observed in trees from that location (figure 2). A similar situation exists farther north, at 407 Jackson St., where total PCB in sample CS-8 is about 2.6 times greater than CS-9. Trees CS-6 and CS-7, collected at 305 Jackson St., were located near some of the least contaminated soils on the Kuhlman property. Both of these samples have concentrations lower than most others along Jackson St.

Samples CS-12, CS-13, CS-14, CS-16 and CS-18 were collected along the floodplain, some of them on or near residential properties. This group includes the first and third most concentrated samples in the data set (CS-16 and CS-12, respectively). The three other samples have total PCB concentrations similar to observations at 403 and 407 Jackson St.

Tree CS-21 was collected across the street from 111 McPherson St., on an embankment. It was out of the floodplain of the stream draining the Kuhlman property which flows immediately adjacent to 111 McPherson St. The total PCB concentration in CS-21, 1468 ng g^{-1} lipid is more than 10 times greater than the least concentrated sample showing that trees close to the stream and floodplain but not immediately in it are exposed to atmospheric gas phase PCB evaporating from floodplain soils. The proximity of tree CS-21 in relation to the stream is much like sample CS-23, collected near the stream, above the floodplain, at 311 W. Railroad Ave which has a concentration of 1399 ng g^{-1} lipid. The PCB concentrations in these trees are very much alike, and the distribution of PCB congeners is highly correlated ($r = 0.807$) (see below). Sample CS-37 was collected in a similar physical setting to CS-21 and CS-23, out of the floodplain but near to it. But sample CS-37 was also near the Kuhlman property. Its total PCB concentration, 3003 ng g^{-1} lipid, is characteristic of trees growing near the Kuhlman property. Its total PCB concentration and age both are comparable to CS-18, which grows in the floodplain, and also to some samples collected along Jackson St., suggesting that the atmospheric PCB concentrations and exposures in the ice house area have been similar to those sites.

Sample CS-31 was collected from a residential property at 100 Pearl St. Its total PCB content, 393 ng g^{-1} lipid, is similar to other samples not adjacent to the Kuhlman facility or near the stream and floodplain north from Kuhlman.

Samples 31, 32 and 33 were collected from residential properties on Lee Ave, across the street to the south from the Kuhlman facility. Concentrations range from 811 to 2494 ng g^{-1} lipid and are directly related to ages of the trees, which range from 6 to greater than 53 years. The appearance of PCB in a 6 year old tree suggests recent and continuing exposure to atmospheric PCB at this site.

Sample 35 was collected from a 19 year old tree near the Crystal Springs High School. Its total PCB concentration, 515 ng g^{-1} lipid, is typical of samples collected in Crystal Springs not adjacent to either the Kuhlman property or the stream that drains the Kuhlman site and its floodplain.

Lipid Content in Tree Bark

The percent lipid concentration (figure3) varied from about 0.5% to 5.8% by mass. Most samples were less than 3% lipid, a pattern typical of trees growing elsewhere in the southern US.

Age of Trees Sampled

Our goal generally was to sample trees less than 30 years old. Of the 26 trees analyzed for PCB reported here, 21 of them started growing after 1972 (figure 4).

PCB Congener Distribution

PCB congener distribution for the 26 samples reported here are shown in figures 5 to 31. I selected the 30 most concentrated peaks in the average of all samples. These peaks represent 48 congeners. In all but one case (CS-27), these 48 congeners represent a minimum of 70 percent of all PCB found in the sample. In sample CS-27, 56 percent of the total PCB is represent by the selected 48 congeners.

Congener distributions from samples collected near each other are highly correlated, even if the total PCB concentrations are variable. Samples CS-1 through CS-5 were collected at 403 Jackson St. The PCB congener distributions are highly correlated, with a minimum correlation coefficient [r] of 0.902 (for samples CS-4 and CS-5). Samples CS-6 and CS-7, collected at 305 Jackson St., have an $r = 0.828$. Samples CS-18 and CS-19, both from the area around 501 Camp St., have an $r = 0.902$. Samples CS-31 and CS-32, from 412 Lee Ave., have $r = 0.7461$, even though one tree is more than 53 years old and the other is 6 years old. These high correlations suggest that the trees are absorbing PCB congeners from the atmospheric gas phase in the same relative proportions, while the total PCB absorption by some trees may be greater than others.

Figures 5 to 9 show the PCB congener distribution patterns of five samples collected from 403 Jackson St. All of these samples show that PCB 153+132+105 is the most concentrated. PCB 180 has a significant presence in all samples, but the samples are also dominated by PCB congeners in the tetrachlorobiphenyl homologue, although trichloro- and dichlorobiphenyl congeners are also present. This dominance is characteristic of an atmospheric gas source, even one dominated by PCB of higher molecular mass, found in Aroclor 1260, known to be used by Kuhlman Electric Corporation.

Figures 10 and 11 show PCB congener distributions for two samples collected along the fence at 305 Jackson St. adjoining the Kuhlman property. These congener distributions are similar to those observed to the north at 403 Jackson St., but include much higher concentrations of PCB 8+5. This congener pair is often dominant in atmospheric gas samples. Since they are not particularly lipophilic, their dominance in these samples, and their appearance in CS-5, suggests that at some point in history a large amount of PCB 8+5 has been present in the atmosphere in this area. Since samples CS-5, CS-6 and CS-7 are older than CS-1 through CS-4, this indicates that PCB 8+5 exposure may have occurred more than 20 years ago.

Samples in Figures 12 and 13 were collected from trees near the northeastern corner of the Kuhlman property in the back yard of 407 Jackson St. These samples are similar with the exception of PCB 8+5 in CS-8. These samples show higher proportions of some higher molecular mass PCB than those collected farther south along Jackson St. These include PCB 170+190, PCB 201, PCB 203+196. The greater proportion of higher molecular mass PCB in tree bark at this location suggests a different congener mix in the source than observed farther south along Jackson St.

Samples CS-12, CS-13, CS-14, CS-16, CS-18 and CS-19 (shown in figures 14-19) were all collected from the floodplain area which is periodically flooded by a contaminated stream draining the Kuhlman property. All of these congener profiles are similar and all are similar to Aroclor 1260 (figure 31), suggesting that congeners found in this Aroclor mixture have had a significant presence in the atmosphere in this area, probably having evaporated from floodplain soils and stream bed sediments during low water periods.

Samples CS-21 and CS-23, both out of the immediate floodplain but in proximity to it, show very similar PCB congener profiles (figures 20-21). CS-21 is somewhat more dominated by higher molecular mass PCB and has fewer peaks appearing in the selected group of congeners.

Samples CS-26, CS-27 and CS-28 (figures 22-24) are also above the floodplain, but farther away from it than CS-21 and CS-23. These samples show greater abundances of lower molecular mass congeners (up to PCB 146) than floodplain samples, and are somewhat more characteristic of samples from 403 Jackson St. The dominance of sample CS-27 by one peak, PCB 66+95, is unusual.

Sample CS-30 (figure 25) has the fewest peaks of any sample in the group selected for showing distribution patterns. This could be interpreted to mean that it is farther away from the source than most other samples which has the effect of lower amounts of less volatile, lower concentrated congeners reaching the tree. That could be the case here.

Samples CS-31, CS-32 and CS-33 (figures 26-28) were collected from residential properties along Lee Ave., across the street to the south from the Kuhlman property. Sample CS-31 is the oldest tree in the group analyzed for PCB, and is dominated by higher molecular mass PCB congeners. It is also unusual in the fact that PCB 153+132+105 is not among the largest 3 peaks. Sample CS-32 was a 6-year-old tree sampled at the same site. While its congener distribution pattern is high correlated to CS-31 ($r > 0.7$), the pattern is not dominated as much by higher molecular mass PCB as CS-31. CS-33 has a congener pattern very similar to CS-32, including a relatively abundant PCB 8+5.

Sample CS-35 (figure 29), from the Crystal Springs High School is largely dominated by 4 peaks (PCB 4+10, 8+5, 180 and 170+190). This distribution suggests that the absorption of these PCB by these trees has occurred at different times. Other than these 4 peaks, most of the other PCB are lower molecular mass congeners, suggesting that these PCB congeners are characteristic of an atmospheric sample. This is typical for a tree that is not immediately near a source, but still affected by it.

The congener distribution in the sample from nearest the ice house site, CS-37, is similar to samples collected from the floodplain (CS-18, for example) with mostly higher molecular mass congeners. This pattern exists even though the tree is not directly in the floodplain, suggesting that atmospheric concentrations at the ice house have been characteristic of the floodplain area at some time during the life of the tree, 19 years.

Summary

The variability of total PCB concentrations in the 26 tree samples reported here show that PCB evaporated into the atmosphere from the Kuhlman site or from floodplain soils have reached a wide area in Crystal Springs. Sites closest to the plant and floodplain soils have been affected most, but all sites have experienced some effect.

The PCB congener distribution patterns show, as expected, that trees close to the source reveal the pattern most characteristic of that source. Since Kuhlman Corporation was known to have used Aroclor 1260, our samples would be expected to show some similarities, as many of them do. Samples that are farther from the direct influence of sources often show a less predictable congener pattern that is dominated by the congeners present in the greatest abundance that are able to reach the site through the atmosphere.

Based on the ages of the trees, it is apparent that atmospheric PCB contamination in Crystal Springs is a recent phenomenon, as recently as the past 6 years. The high PCB concentration in a floodplain tree that is 26 years old shows that high levels of atmospheric PCB contamination have been found in parts of Crystal Springs since about the time PCB production was coming to a close in North America. Even when the Kuhlman Company stopped using PCB, the atmosphere was still receiving PCB from the plant site and from floodplain soils as shown by trees less than 20 years old.

References

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Hermanson, M. H. and Hites, R. A. *Long-term measurements of atmospheric polychlorinated biphenyls in the vicinity of Superfund dumps.* **Environmental Science & Technology** 1989, *23*, 1253-1258.

Horsak, R. *Environmental Site Assessment: The fate and transport of polychlorinated biphenyls from the Kuhlman Electric plant site to off-site residential and public areas in Crystal Springs, MS.* 3TM International, Inc. April 4, 2003.

Manchester-Neesvig, J. B., Andren, A. W. *Seasonal variation in the atmospheric concentration of polychlorinated biphenyl congeners.* **Environmental Science & Technology** 1989, *23*, 1138-1154.

Mullin, M. PCB Workshop. Grosse Ile, MI. 1985.

Table I. Tree Bark Sampling Site and Descriptions.

Crystal Springs, Mississippi

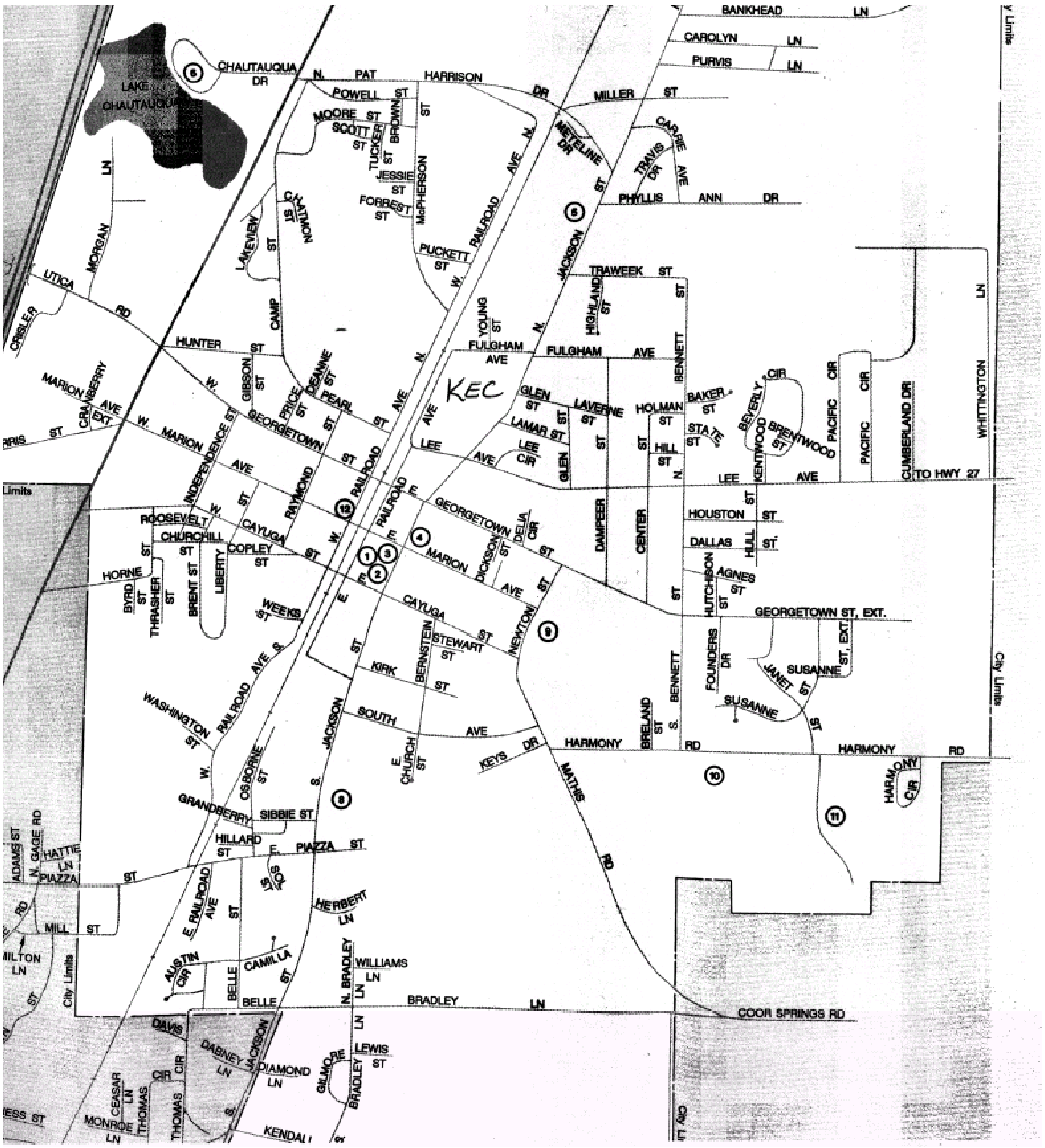
Bark sampling, 2003

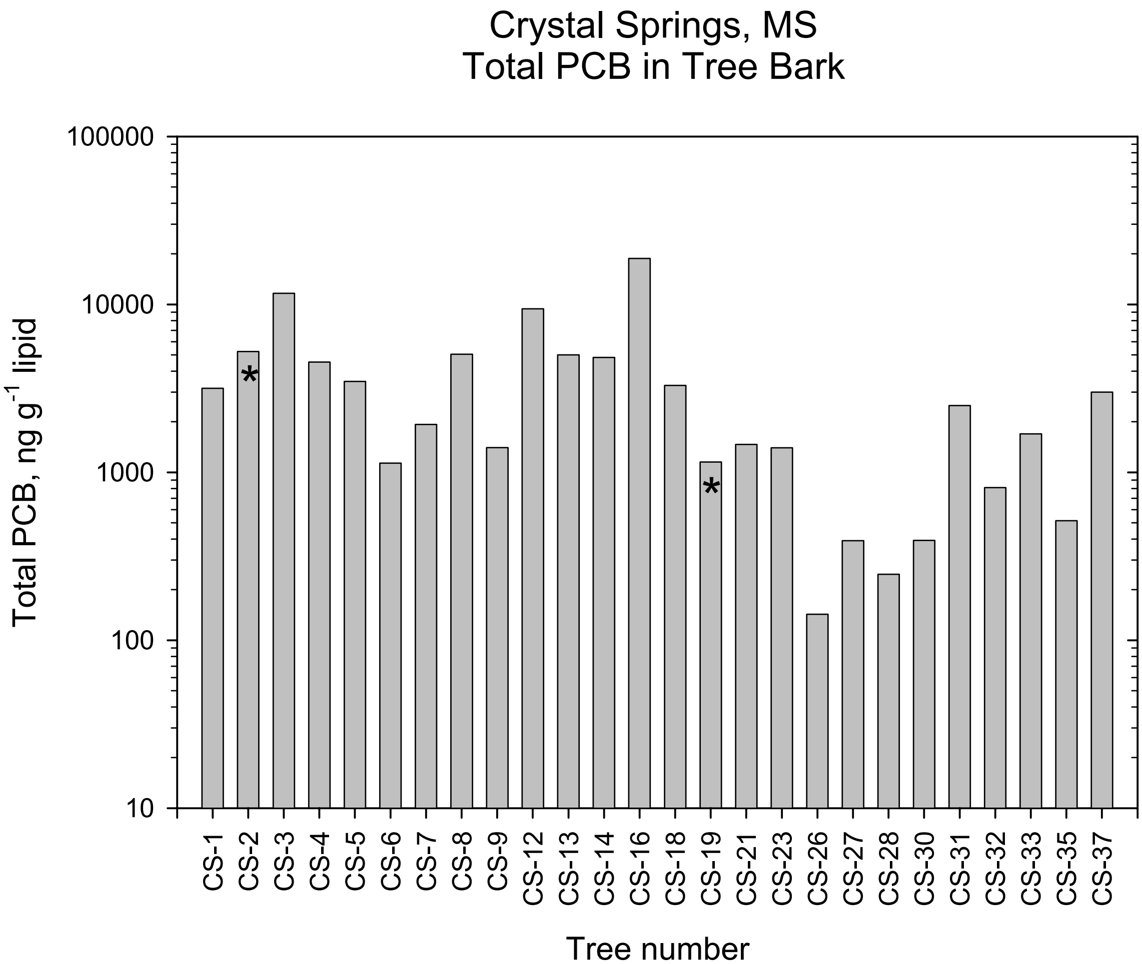
Sample	Location	Lat North	Long West	Type	Circum. cm	Ring Count	Age years
CS- 1	403 Jackson	31-59-25.3	90-21-12.3	water oak	85	**18**	18
CS- 2	403 Jackson			water oak	54	17	17
CS- 3	403 Jackson			hackberry	87	**13**	13
CS- 4	403 Jackson			oak	56	**18**	18
CS- 5	403 Jackson			water oak	220	18	55
CS- 6	305 Jackson	31-59-24.7	90-21-14.7	pine	135	**28**	28
CS- 7	305 Jackson			water oak	127	17	24
CS- 8	407 Jackson	31-59-26.9	90-21-11.7	water oak	161	20	28
CS- 9	407 Jackson			pecan(?)	170	25	38
CS- 10	407 Jackson			water oak	83	0	
CS- 11	~107 Forrest	31-59-42.5	90-21-26.5	water oak	238	37	68
CS- 12	~107 Forrest				69	15	15
CS- 13	flood plain	31-59-44.7	90-21-30.8		56	17	17
CS- 14	flood plain			ash	73	34	39
CS- 15	flood plain			water oak	274	52	98
CS- 16	flood plain	31-59-46.5	90-21-33.2		80	**26**	26
CS- 17	flood plain			sycamore	180	25	27
CS- 18	501 Camp St.			elm	72	**18**	18
CS- 19	501 Camp St.			elm	49.5	**22**	22
CS- 20	104 Forrest			elm	101	**15**	15
CS- 21	111 McPherson	31-59-38.0	90-20-23.6	elm	74	**41**	41
CS- 22	111 McPherson	31-59-40.9	90-21-24.7	water oak	131.5	27	27
CS- 23	311 Railroad Ave	31-59-33.7	90-21-22.1	pecan	72	**29**	29
CS- 24	108 Tucker	31-59-43.6	90-21-31.0	pecan	96	**23**	23
CS- 25	106 Tucker			tallow	78	**21**	21
CS- 26	105 Tucker	31-59-48.4	90-21-27.3	water oak	69	**18**	18
CS- 27	103 Tucker			pine	80	**14**	14
CS- 28	302 McPherson	31-59-41.9	90-21-23.3	pine	84	**16**	16
CS- 29	302 McPherson			pecan	84	**15**	15
CS- 30	100 Pearl St.	31-59-21.2	90-21-28.5	elm	71	**13**	13
CS- 31	412 Lee Ave.	31-59-19.2	90-21-20.9	hackberry	307	26	53
CS- 32	412 Lee Ave.			tallow	68	8	8
CS- 33	406 Lee Ave.			elm	86	**24**	24
CS- 34	Ice house	31-59-30.3	90-21-17.3	oak	73	**12**	12
CS- 35	CSHS	31-59-03.3	90-21-9.3	water oak	54	**19**	19
CS- 36	Ice house	31-59-30.3	90-21-17.3	water oak	384	26	103
CS- 37	Ice house				71	**19**	19

NOTES:
Bold ring counts are for trees where center was reached. Ring count is actual age.
Non-bold ring counts are trees with calculated ages based on collected rings, growth rates and circumference.

List of Figures

Figure 1. Street map of Crystal Springs, Mississippi. KEC refers to Kuhlman Electric Corporation Site. Note that numbers on the map are not references to tree samples.





*Note: All surrogate recoveries in these samples <50%.

Figure 2.

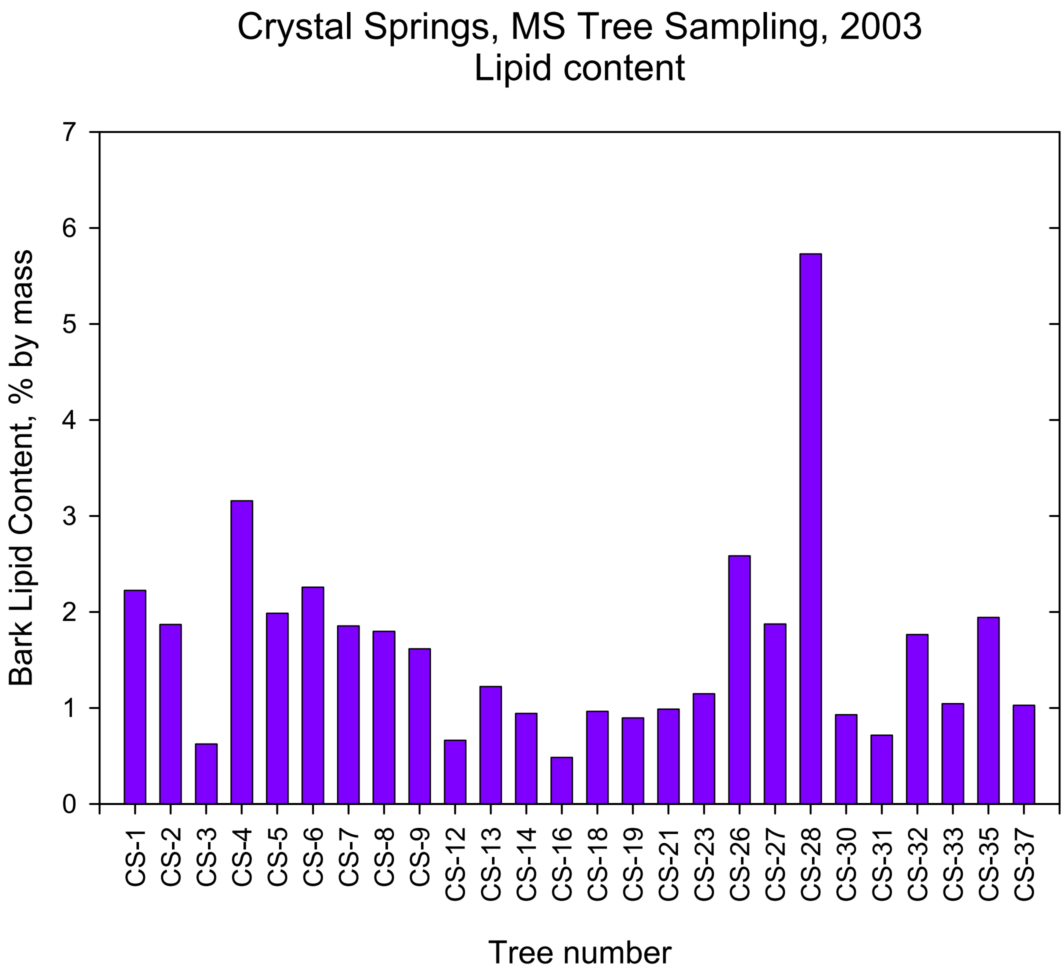
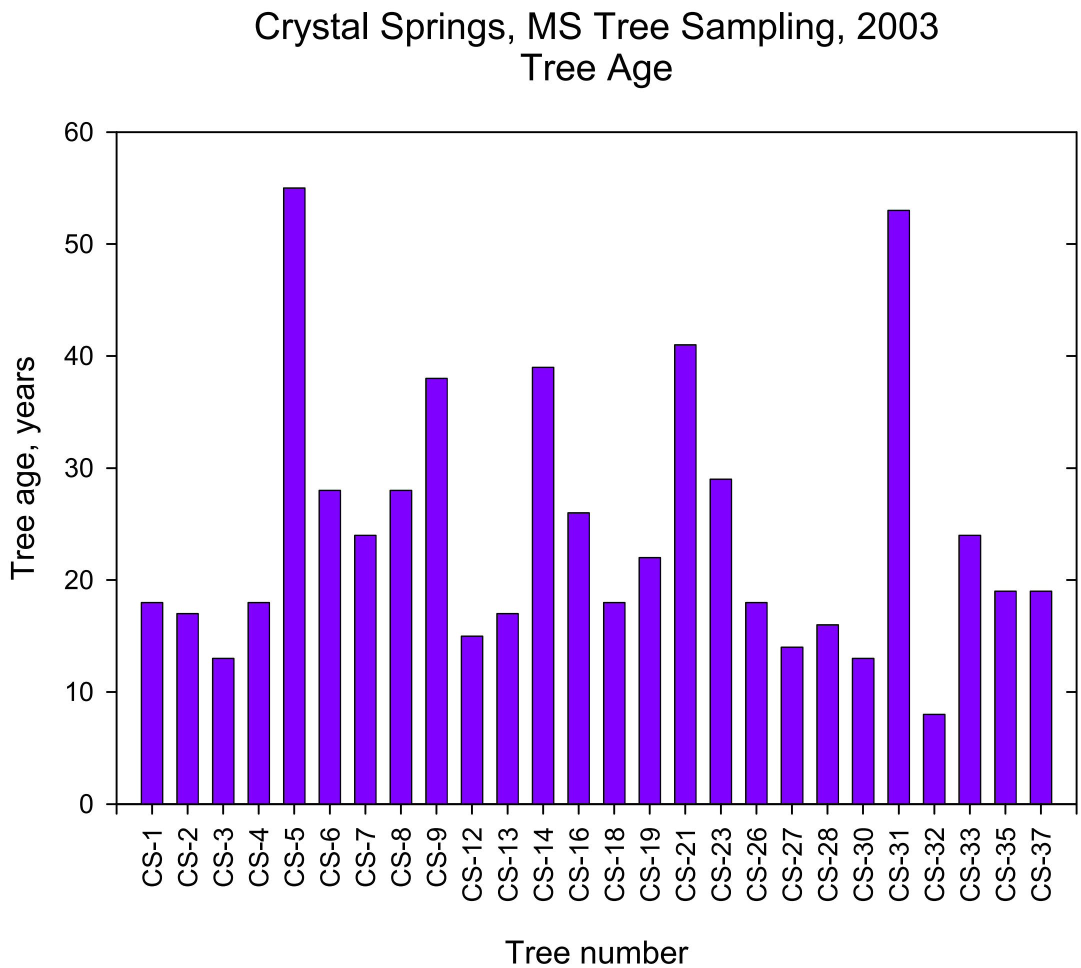

Crystal Springs, MS Tree Sampling, 2003
Lipid content
Bark Lipid Content, % by mass
0
1
2
3
4
5
6
7
CS-1
CS-2
CS-3
CS-4
CS-5
CS-6
CS-7
CS-8
CS-9
CS-12
CS-13
CS-14
CS-16
CS-18
CS-19
CS-21
CS-23
CS-26
CS-27
CS-28
CS-30
CS-31
CS-32
CS-33
CS-35
CS-37
Tree number

Figure 3.



Crystal Springs, MS Tree Sampling, 2003
Tree Age
Tree age, years
0
10
20
30
40
50
60
CS-1
CS-2
CS-3
CS-4
CS-5
CS-6
CS-7
CS-8
CS-9
CS-12
CS-13
CS-14
CS-16
CS-18
CS-19
CS-21
CS-23
CS-26
CS-27
CS-28
CS-30
CS-31
CS-32
CS-33
CS-35
CS-37
Tree number

Figure 4.

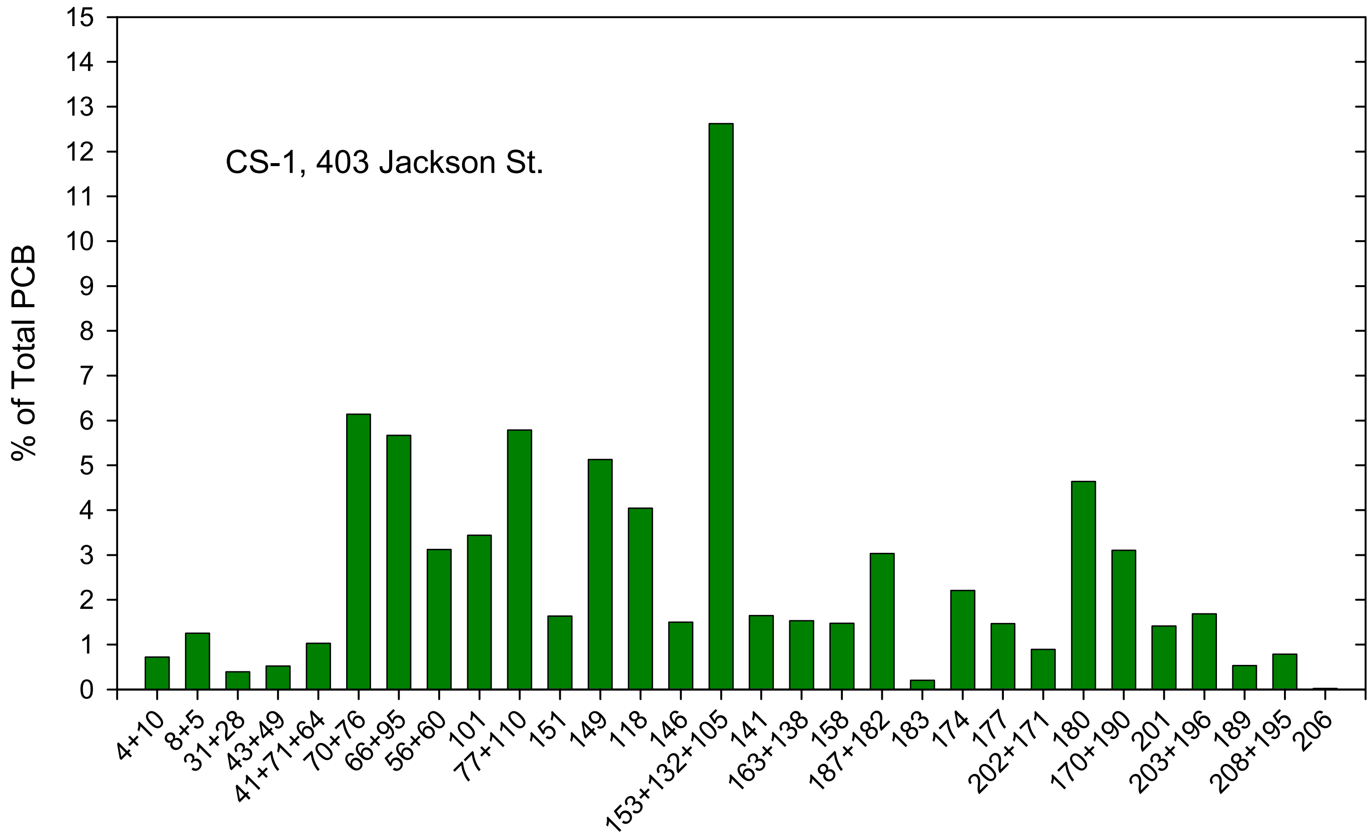

15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
% of Total PCB
CS-1, 403 Jackson St.
4+10
8+5
31+28
43+49
41+71+64
70+76
66+95
56+60
101
77+110
151
149
118
146
153+132+105
141
163+138
158
187+182
183
174
177
202+171
180
170+190
201
203+196
189
208+195
206

Figure 5.

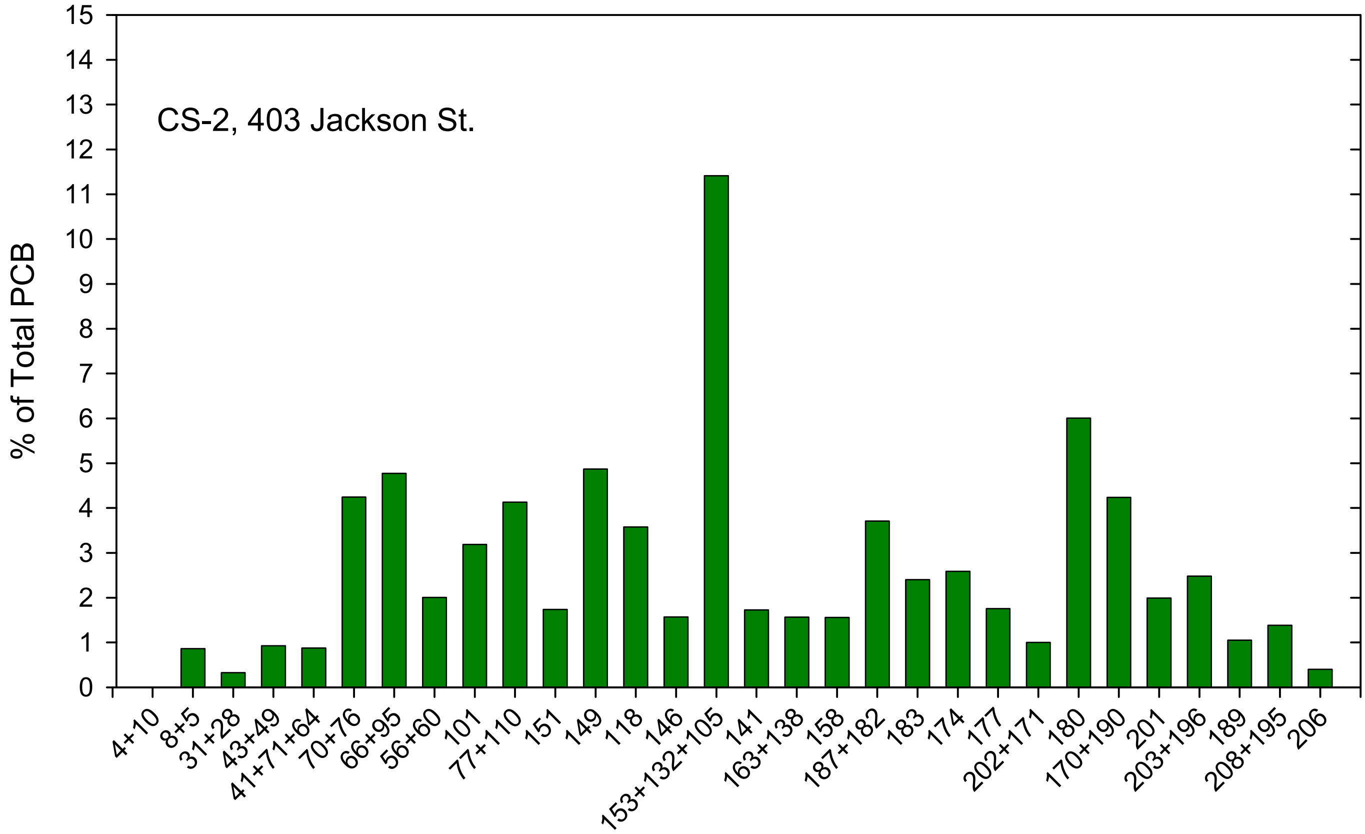

15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
CS-2, 403 Jackson St.
% of Total PCB
4+10
8+5
31+28
43+49
41+71+64
70+76
66+95
56+60
101
77+110
151
149
118
146
153+132+105
141
163+138
158
187+182
183
174
177
202+171
180
170+190
201
203+196
189
208+195
206

Figure 6.

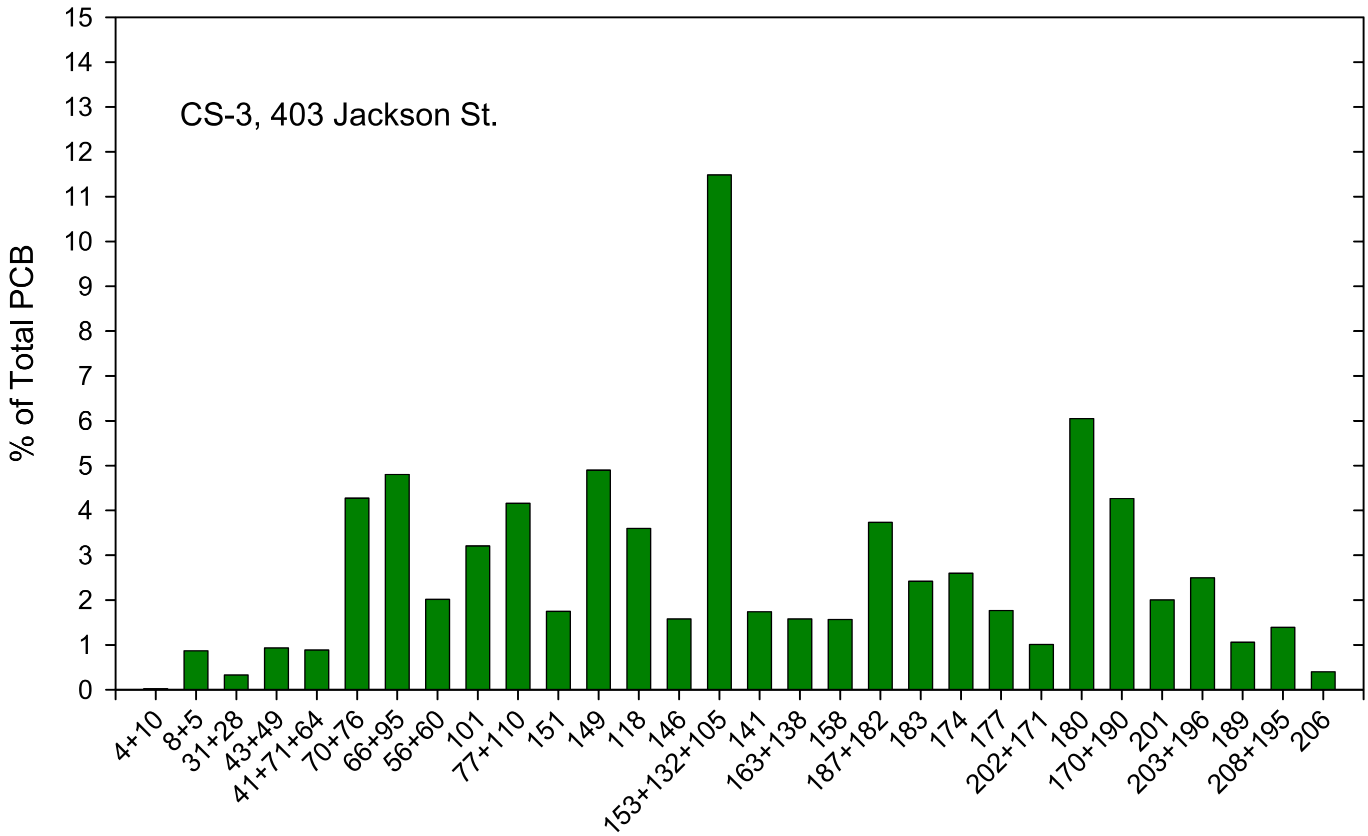
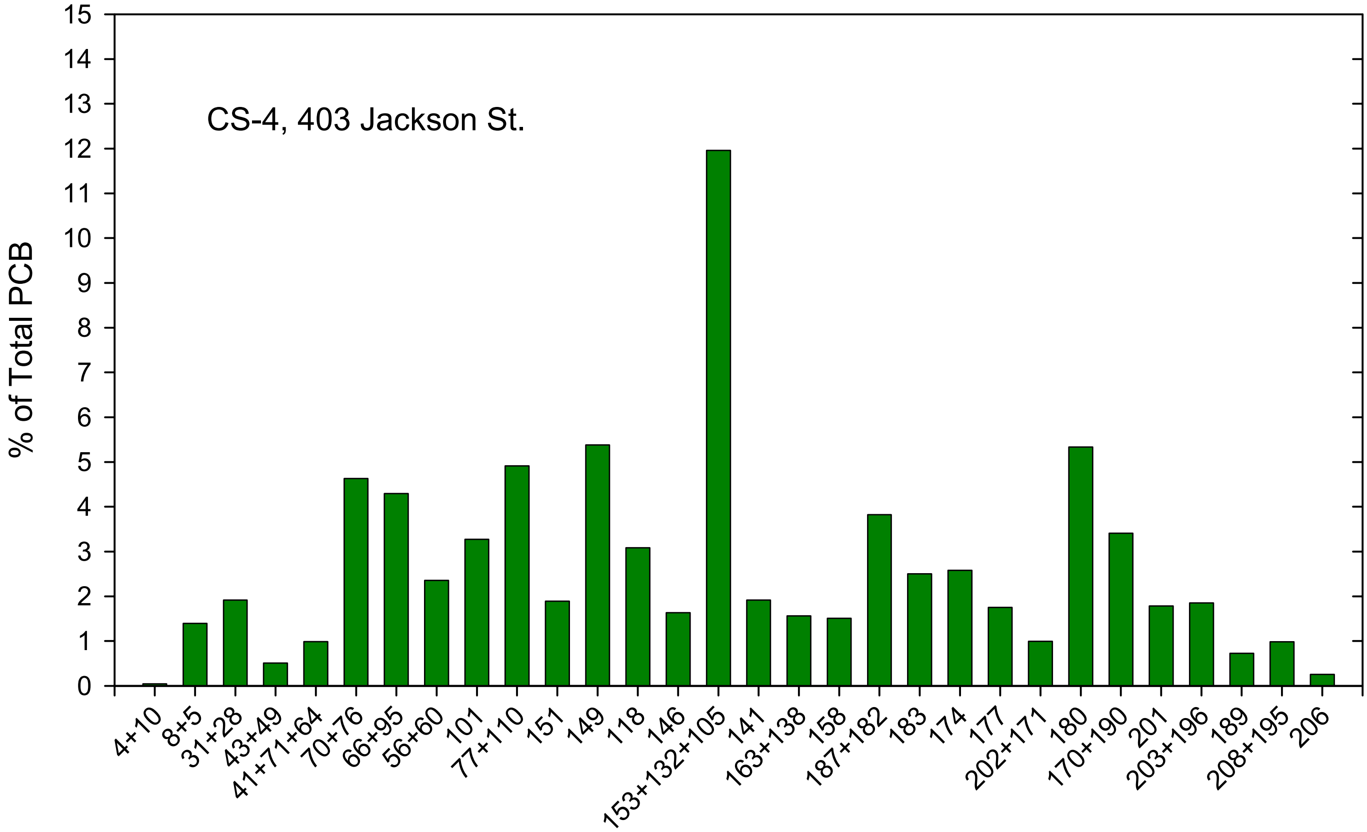
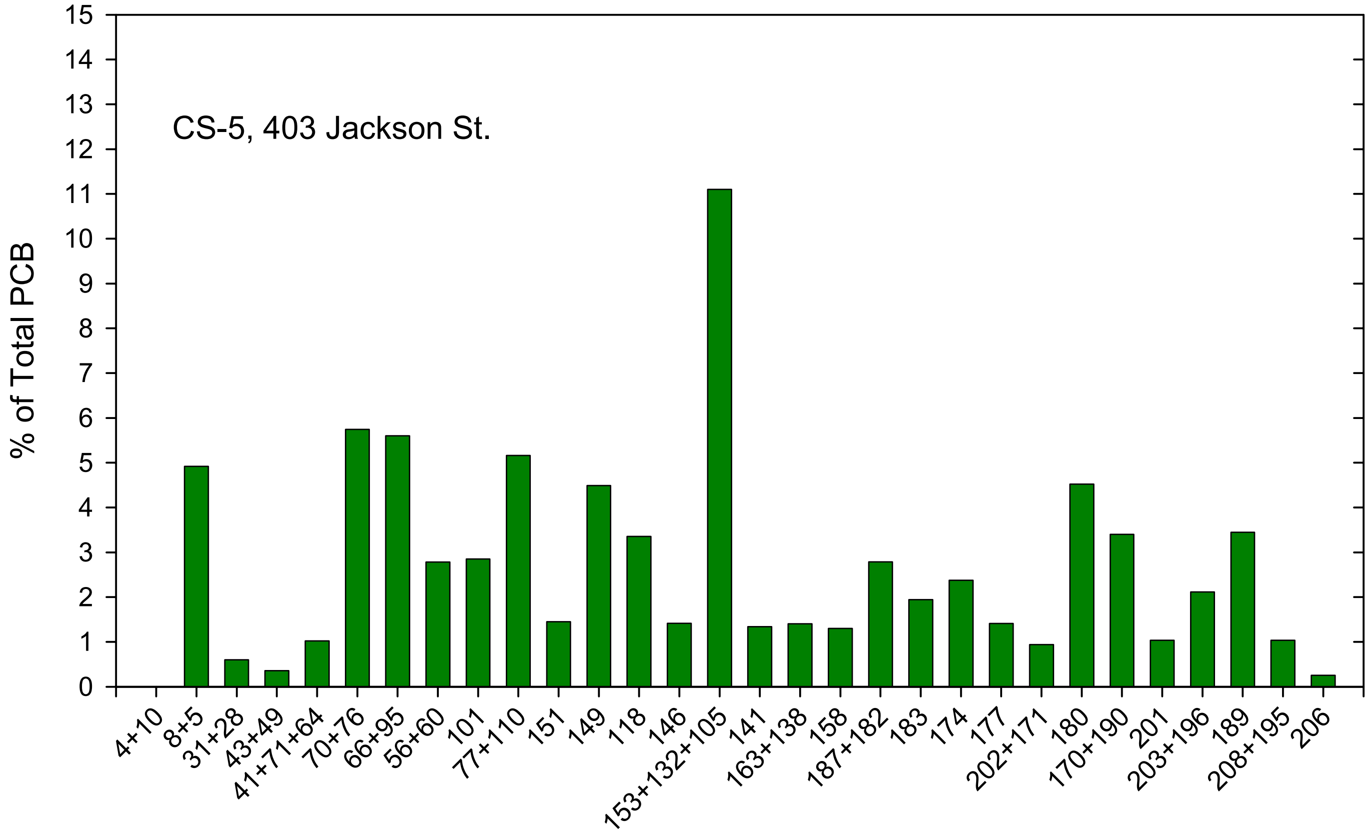

CS-3, 403 Jackson St.
% of Total PCB
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
4+10
8+5
31+28
43+49
41+71+64
70+76
66+95
56+60
101
77+110
151
149
118
146
153+132+105
141
163+138
158
187+182
183
174
177
202+171
180
170+190
201
203+196
189
208+195
206

Figure 7.



CS-4, 403 Jackson St.
% of Total PCB
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
4+10
8+5
31+28
43+49
41+71+64
70+76
66+95
56+60
101
77+110
151
149
118
146
153+132+105
141
163+138
158
187+182
183
174
177
202+171
180
170+190
201
203+196
189
208+195
206

Figure 8.



CS-5, 403 Jackson St.
% of Total PCB
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
4+10
8+5
31+28
43+49
41+71+64
70+76
66+95
56+60
101
77+110
151
149
118
146
153+132+105
141
163+138
158
187+182
183
174
177
202+171
180
170+190
201
203+196
189
208+195
206

Figure 9.

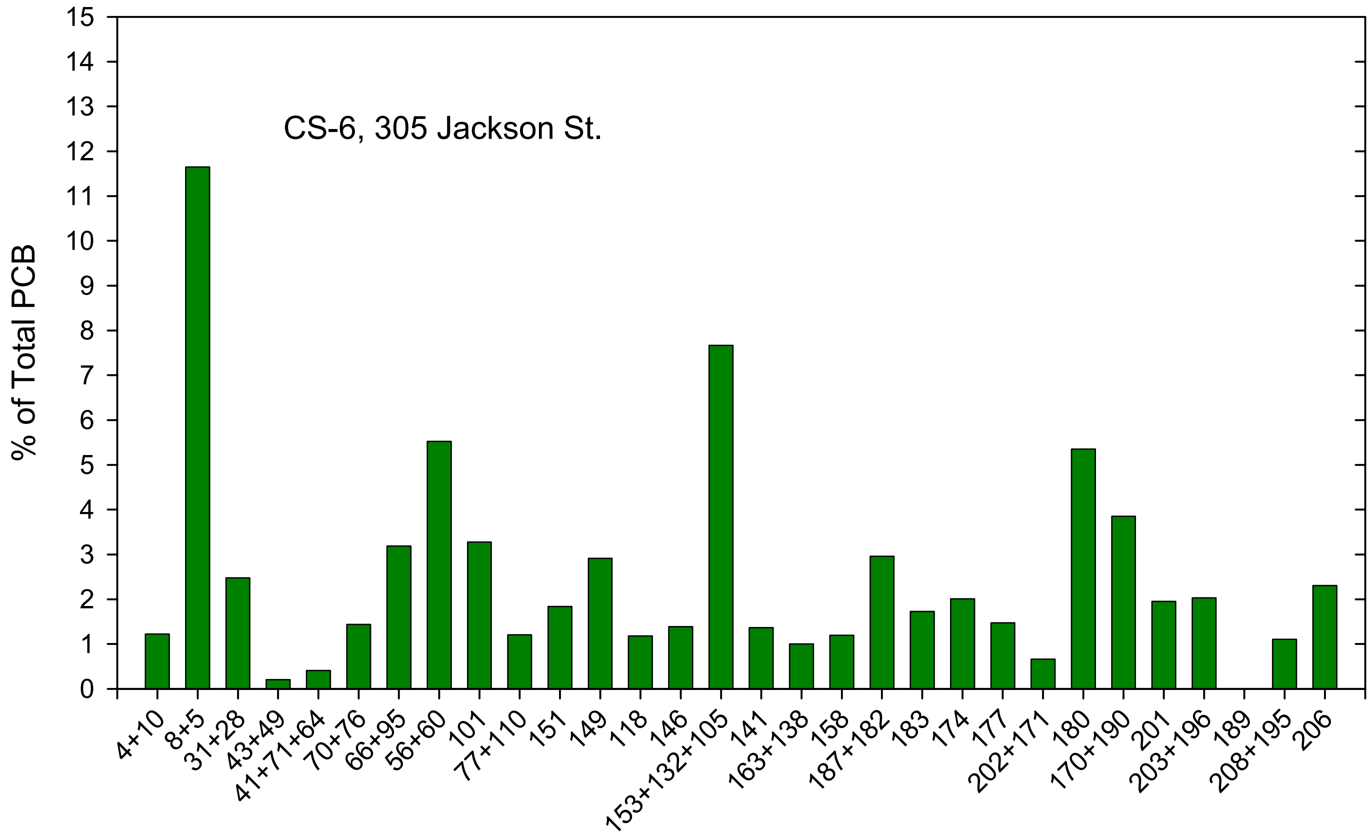
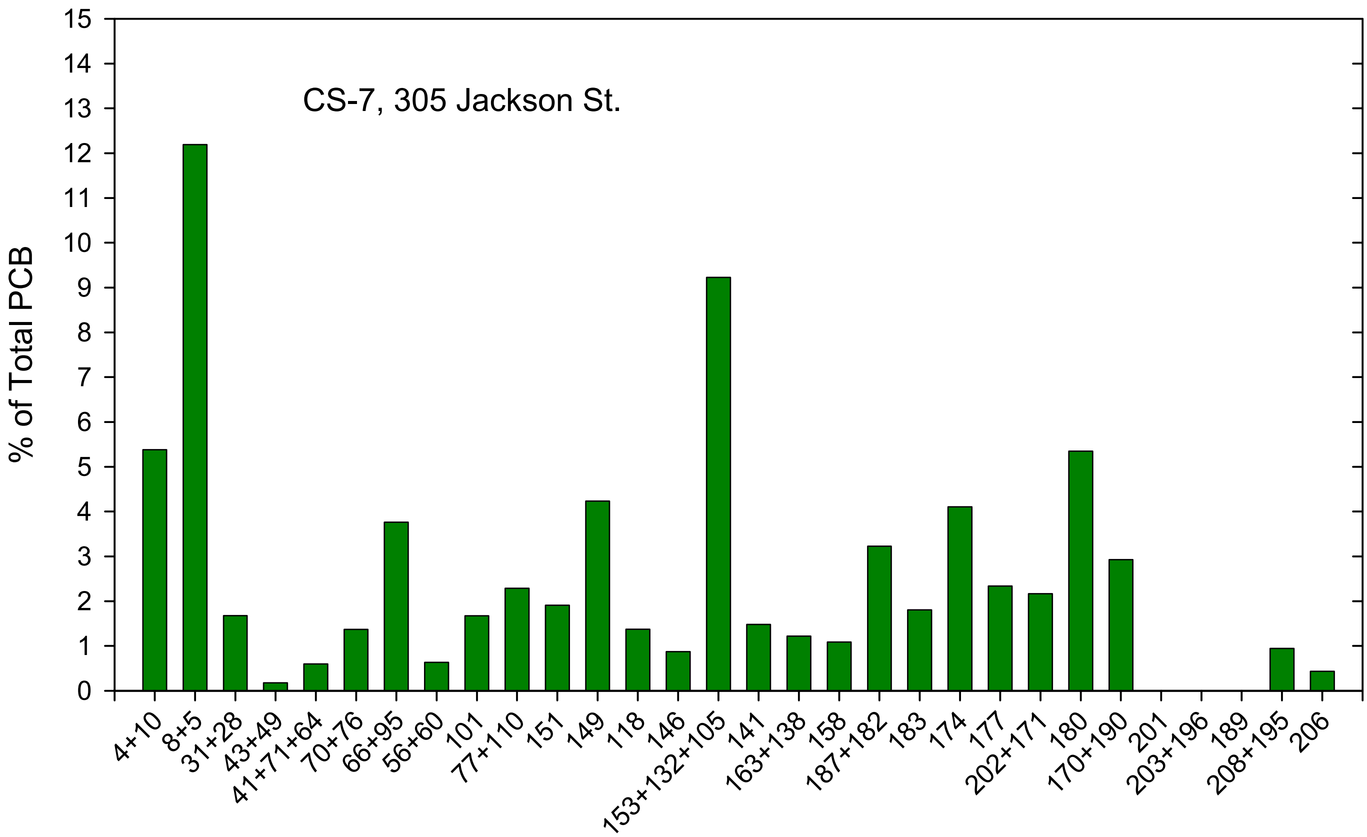

CS-6, 305 Jackson St.
% of Total PCB
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
4+10
8+5
31+28
43+49
41+71+64
70+76
66+95
56+60
101
77+110
151
149
118
146
153+132+105
141
163+138
158
187+182
183
174
177
202+171
180
170+190
201
203+196
189
208+195
206

Figure 10.


CS-7, 305 Jackson St.
% of Total PCB
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
4+10
8+5
31+28
43+49
41+71+64
70+76
66+95
56+60
101
77+110
151
149
118
146
153+132+105
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174
177
202+171
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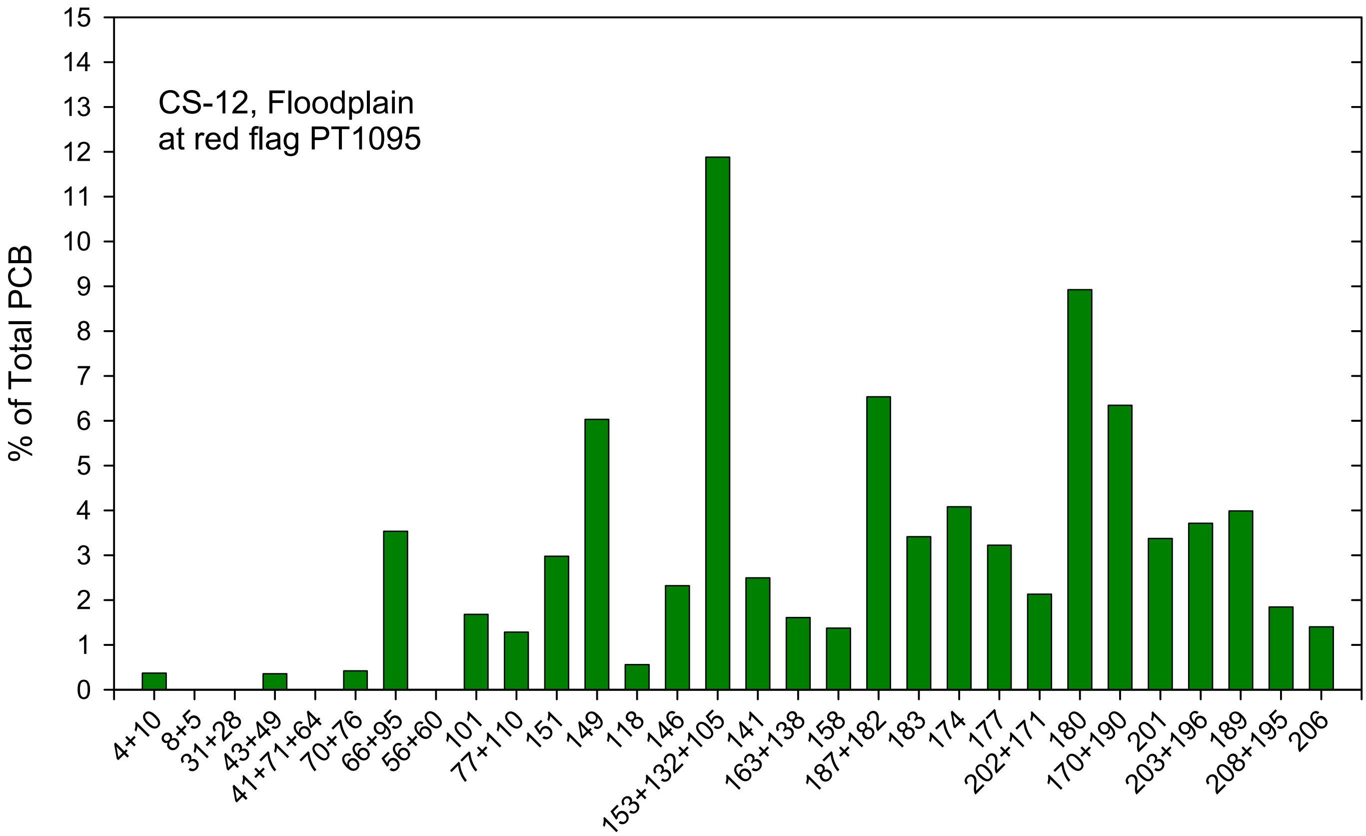
170+190
201
203+196
189
208+195
206

Figure 11.



CS-12, Floodplain
at red flag PT1095
% of Total PCB
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
4+10
8+5
31+28
43+49
41+71+64
70+76
66+95
56+60
101
77+110
151
149
118
146
153+132+105
141
163+138
158
187+182
183
174
177
202+171
180
170+190
201
203+196
189
208+195
206

Figure 12

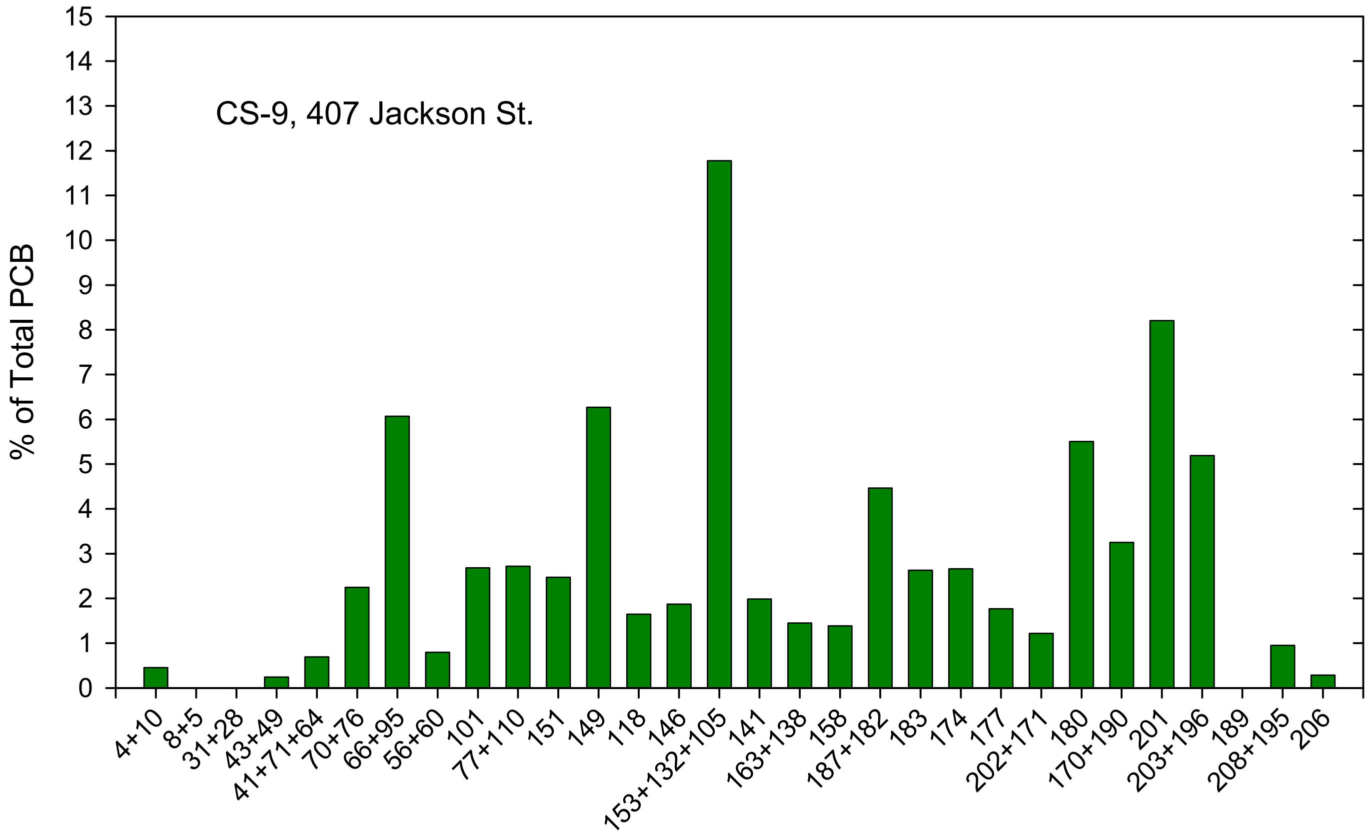

CS-9, 407 Jackson St.
% of Total PCB
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
4+10
8+5
31+28
43+49
41+71+64
70+76
66+95
56+60
101
77+110
151
149
118
146
153+132+105
141
163+138
158
187+182
183
174
177
202+171
180
170+190
201
203+196
189
208+195
206

Figure 13.

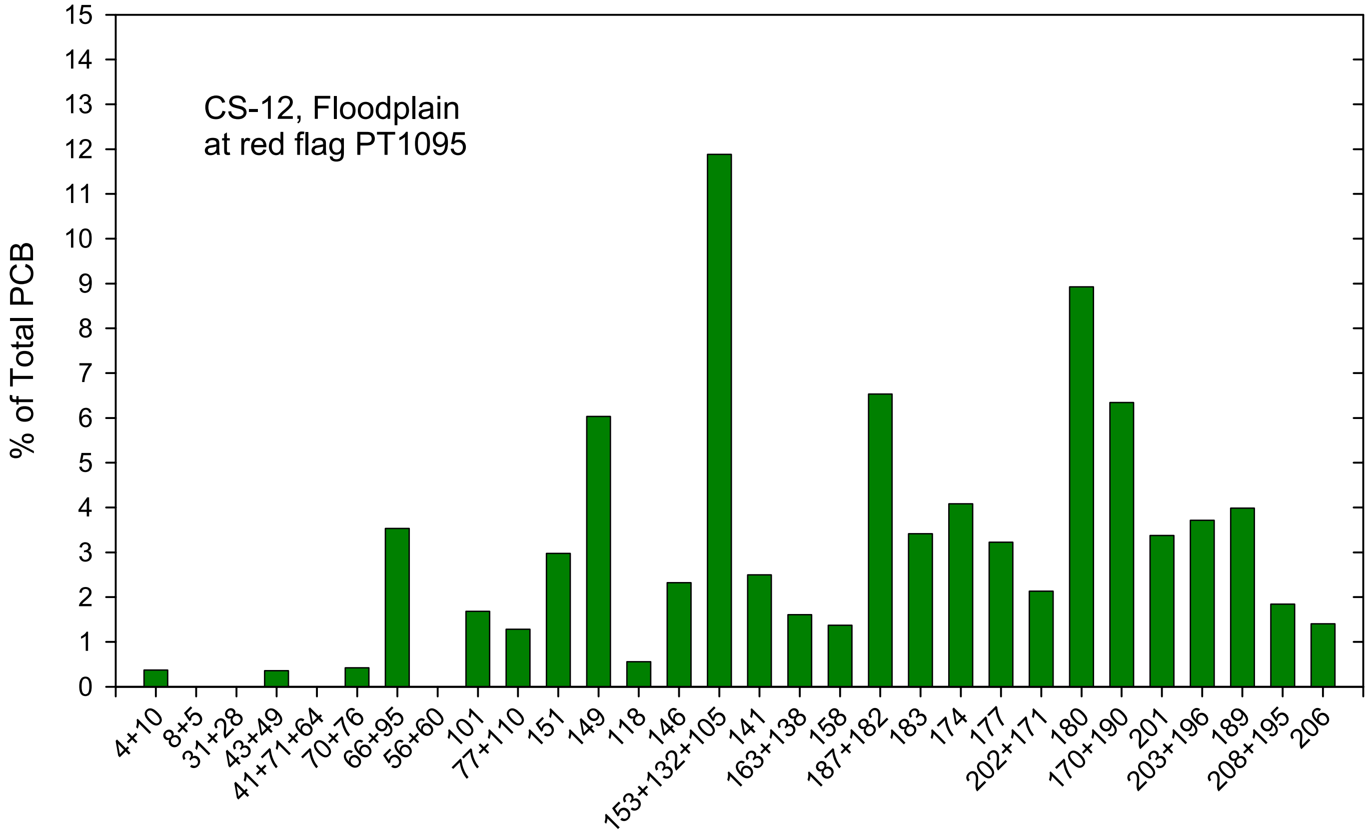
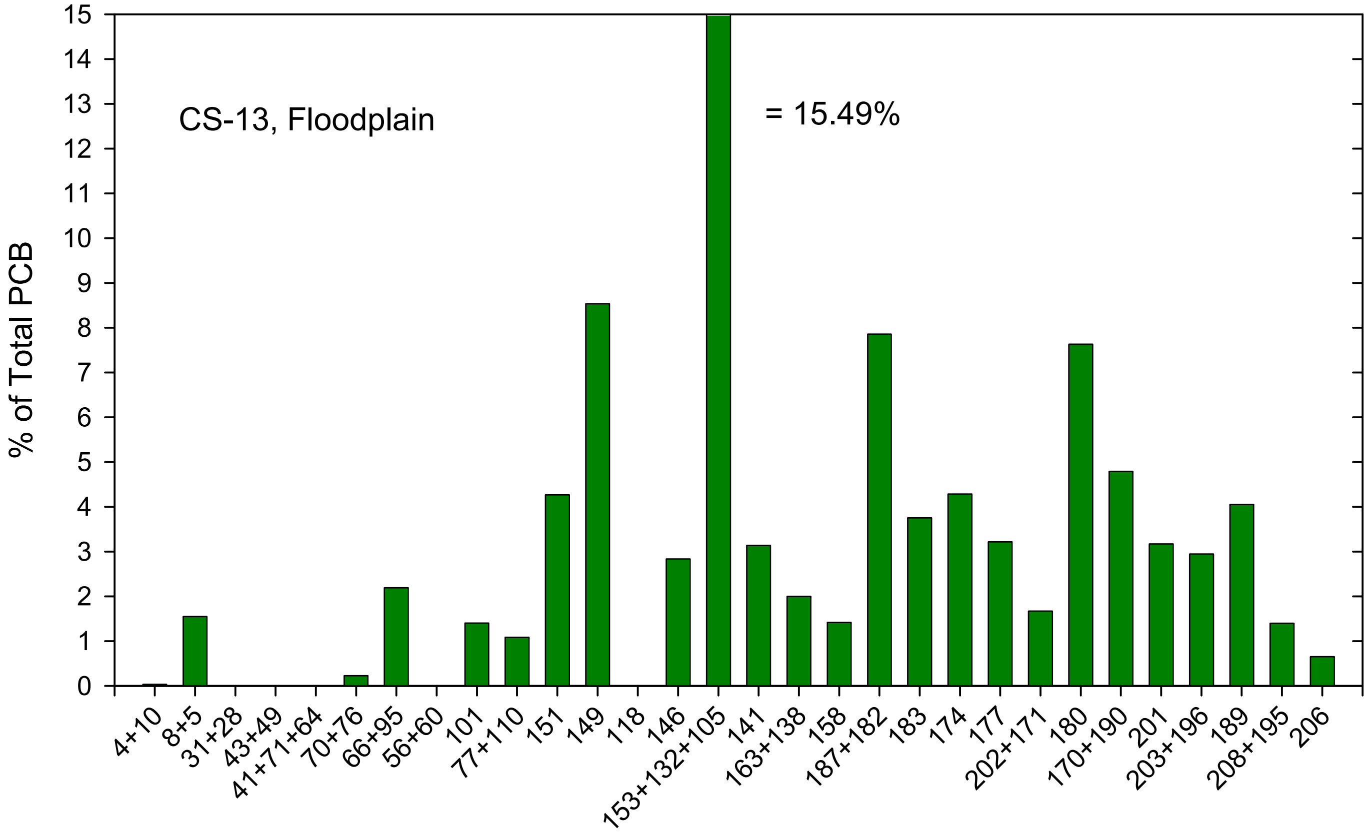

CS-12, Floodplain
at red flag PT1095
% of Total PCB
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
4+10
8+5
31+28
43+49
41+71+64
70+76
66+95
56+60
101
77+110
151
149
118
146
153+132+105
141
163+138
158
187+182
183
174
177
202+171
180
170+190
201
203+196
189
208+195
206

Figure 14



% of Total PCB
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
CS-13, Floodplain
= 15.49%
4+10
8+5
31+28
43+49
41+71+64
70+76
66+95
56+60
101
77+110
151
149
118
146
153+132+105
141
163+138
158
187+182
183
174
177
202+171
180
170+190
201
203+196
189
208+195
206

Figure 15.

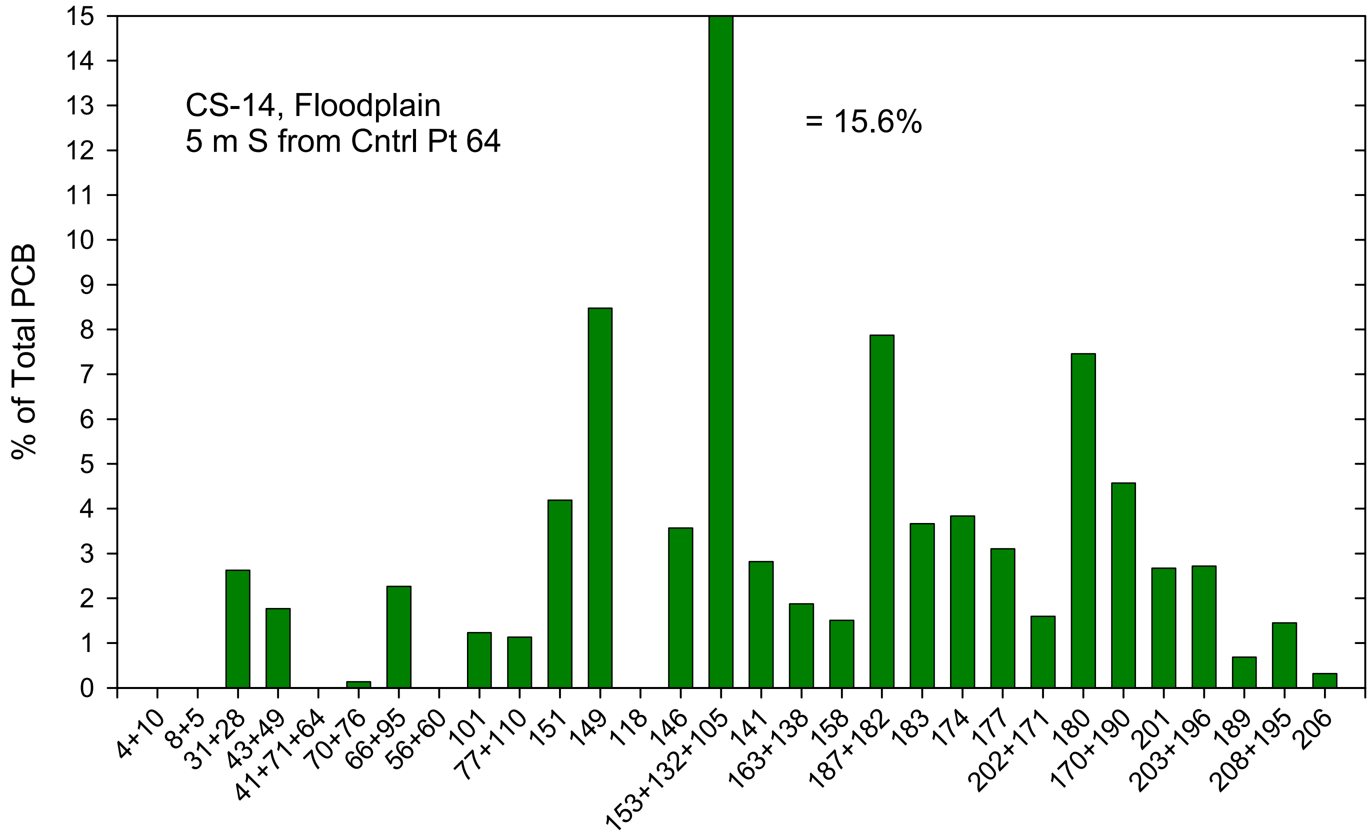

CS-14, Floodplain
5 m S from Cntrl Pt 64
= 15.6%
% of Total PCB
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
4+10
8+5
31+28
43+49
41+71+64
70+76
66+95
56+60
101
77+110
151
149
118
146
153+132+105
141
163+138
158
187+182
183
174
177
202+171
180
170+190
201
203+196
189
208+195
206

Figure 16.

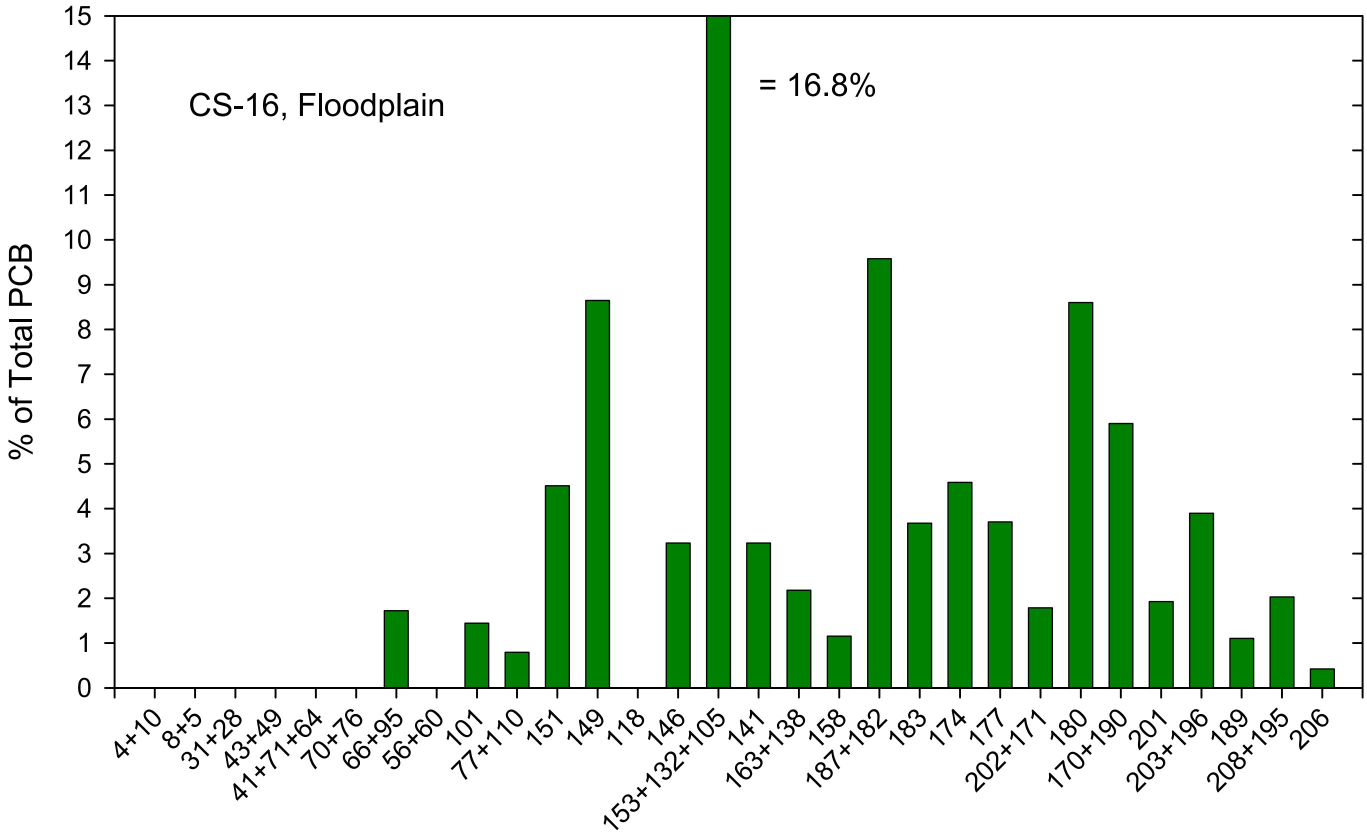

CS-16, Floodplain
= 16.8%
% of Total PCB
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
4+10
8+5
31+28
43+49
41+71+64
70+76
66+95
56+60
101
77+110
151
149
118
146
153+132+105
141
163+138
158
187+182
183
174
177
202+171
180
170+190
201
203+196
189
208+195
206

Figure 17.

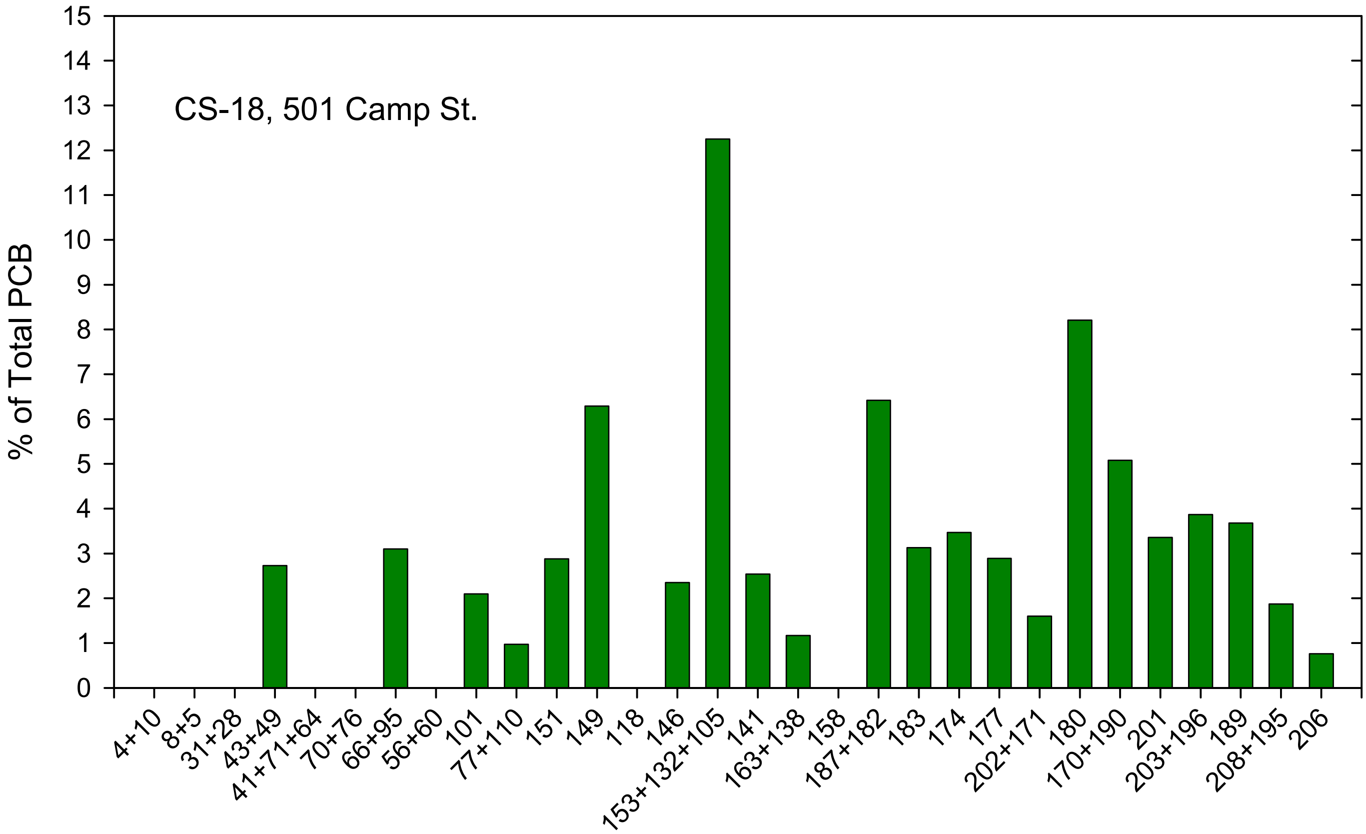

CS-18, 501 Camp St.
% of Total PCB
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
4+10
8+5
31+28
43+49
41+71+64
70+76
66+95
56+60
101
77+110
151
149
118
146
153+132+105
141
163+138
158
187+182
183
174
177
202+171
180
170+190
201
203+196
189
208+195
206

Figure 18.

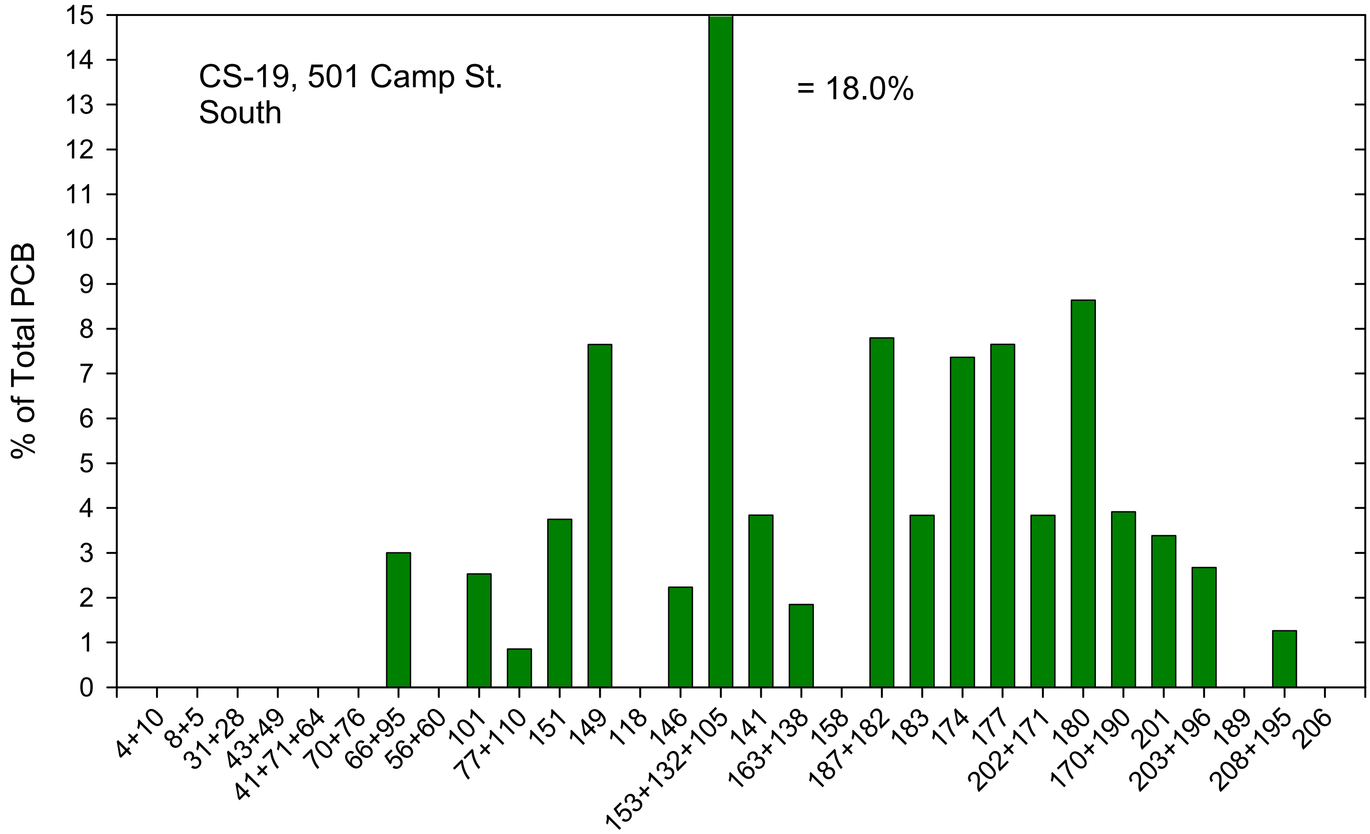

CS-19, 501 Camp St.
South
= 18.0%
% of Total PCB
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
4+10
8+5
31+28
43+49
41+71+64
70+76
66+95
56+60
101
77+110
151
149
118
146
153+132+105
141
163+138
158
187+182
183
174
177
202+171
180
170+190
201
203+196
189
208+195
206

Figure 19.

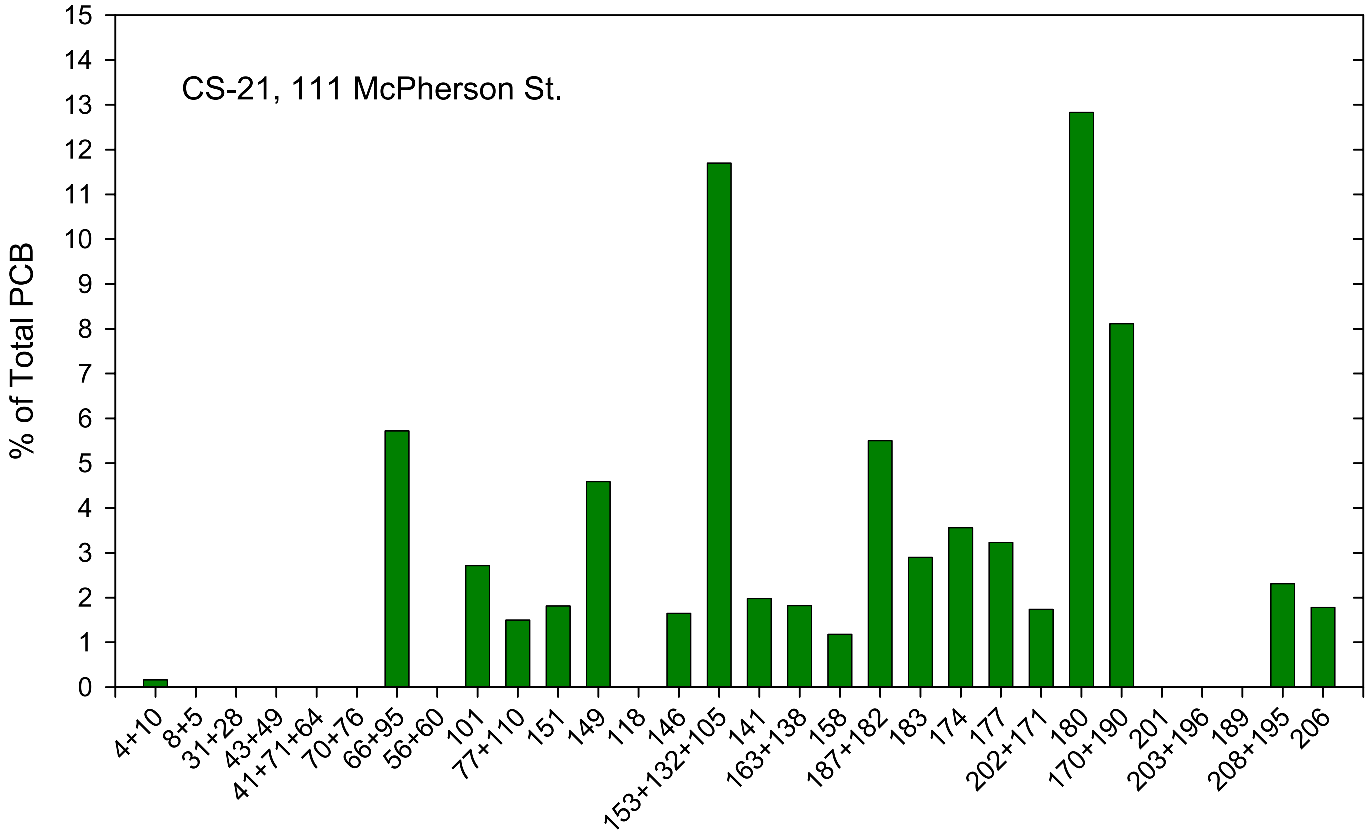

CS-21, 111 McPherson St.
% of Total PCB
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
4+10
8+5
31+28
43+49
41+71+64
70+76
66+95
56+60
101
77+110
151
149
118
146
153+132+105
141
163+138
158
187+182
183
174
177
202+171
180
170+190
201
203+196
189
208+195
206

Figure 20.

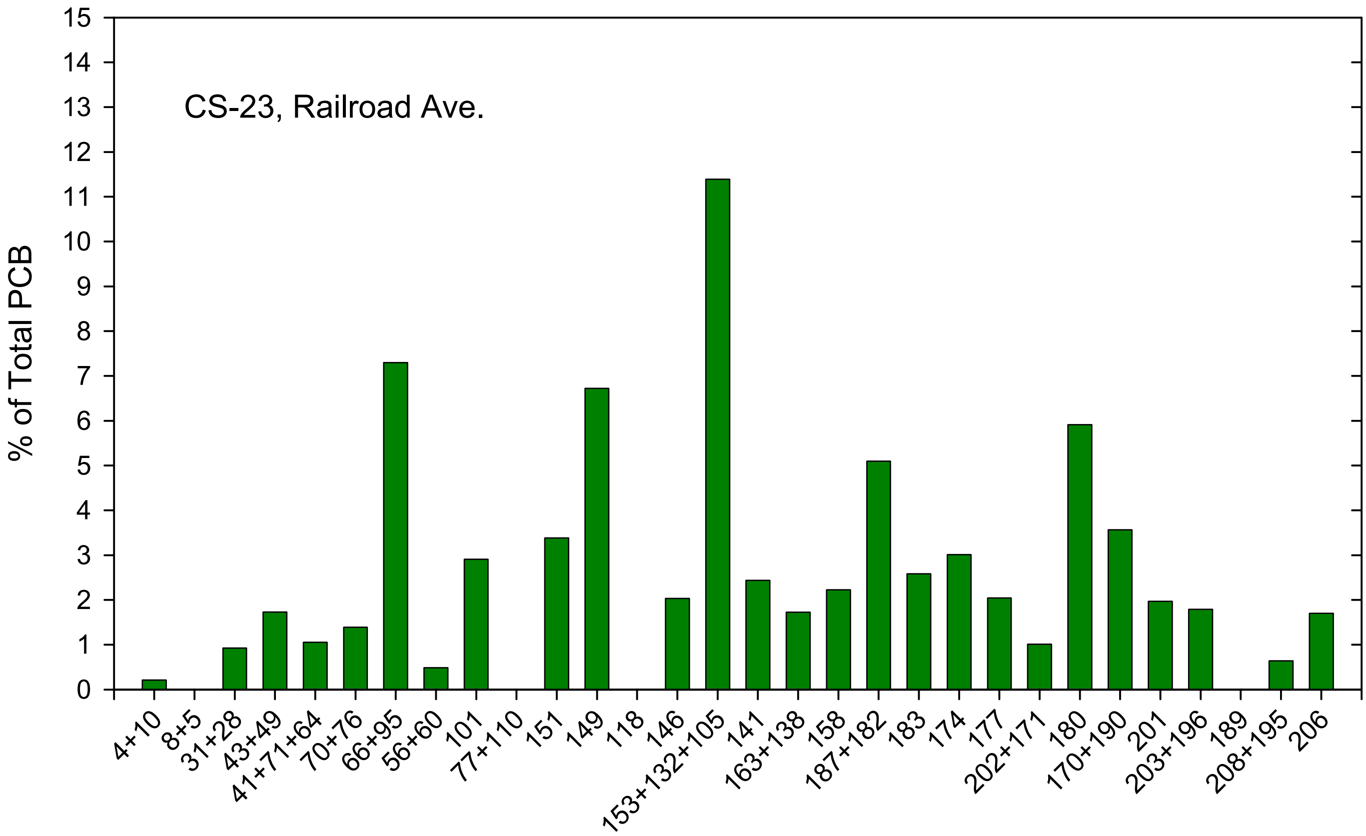

CS-23, Railroad Ave.
% of Total PCB
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
4+10
8+5
31+28
43+49
41+71+64
70+76
66+95
56+60
101
77+110
151
149
118
146
153+132+105
141
163+138
158
187+182
183
174
177
202+171
180
170+190
201
203+196
189
208+195
206

Figure 21.

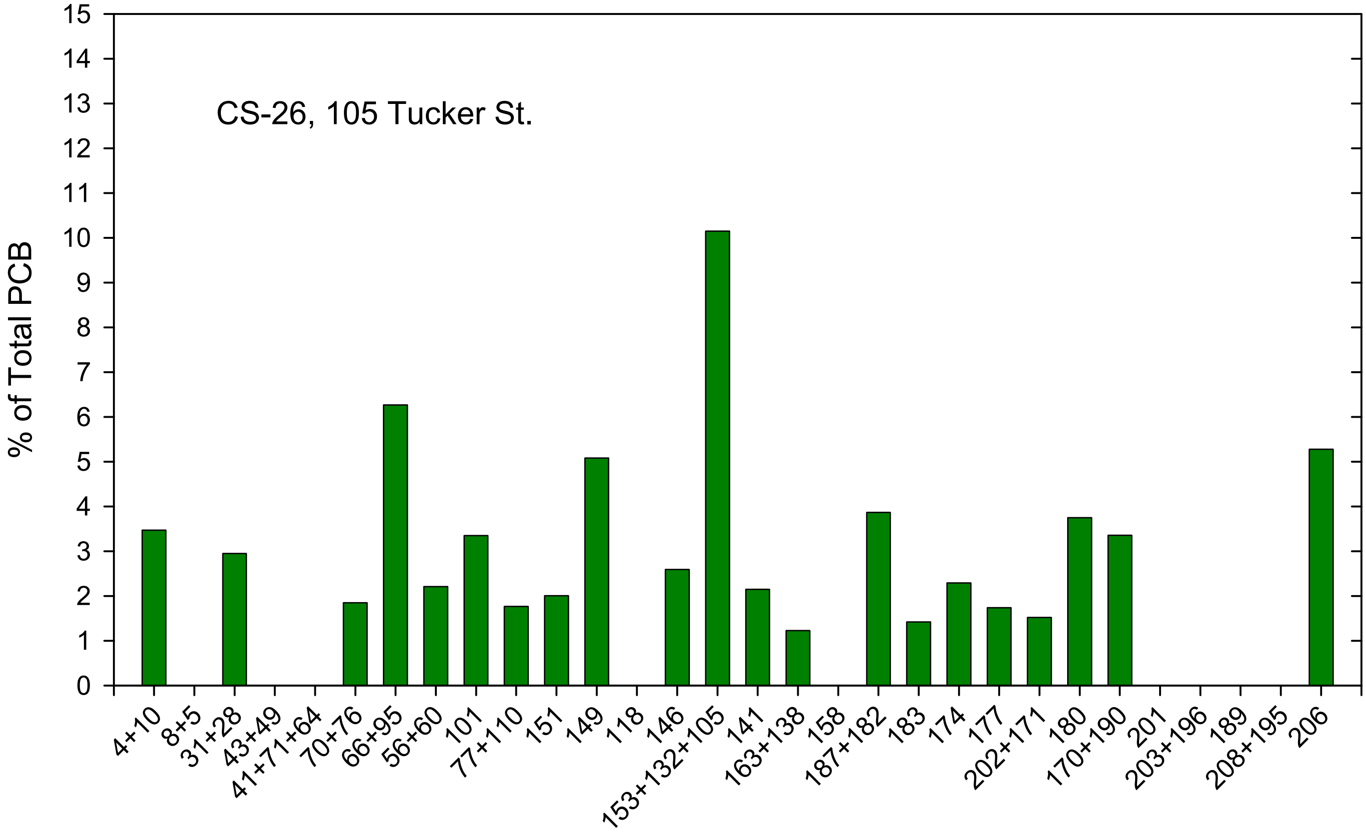

CS-26, 105 Tucker St.
% of Total PCB
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
4+10
8+5
31+28
43+49
41+71+64
70+76
66+95
56+60
101
77+110
151
149
118
146
153+132+105
141
163+138
158
187+182
183
174
177
202+171
180
170+190
201
203+196
189
208+195
206

Figure 22.

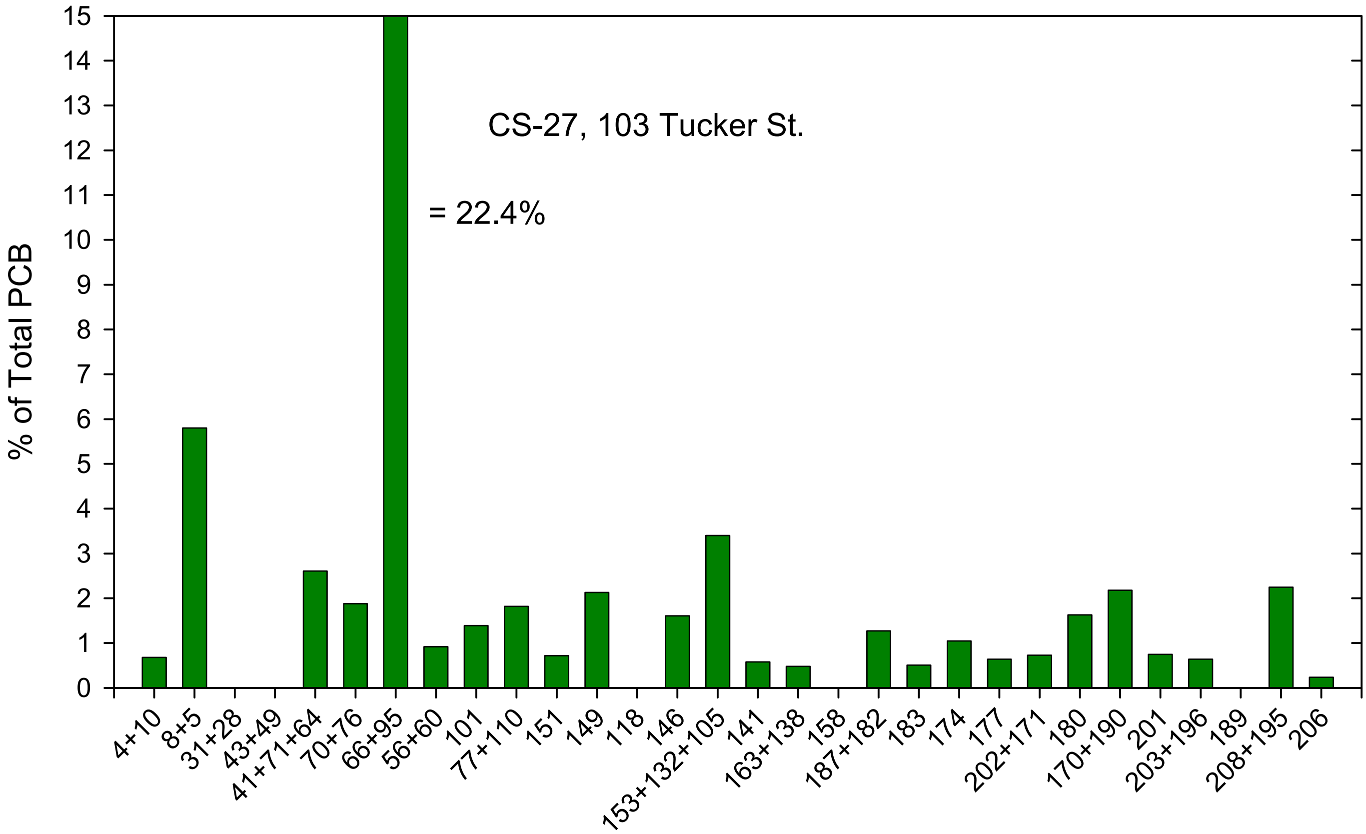

CS-27, 103 Tucker St.
= 22.4%
% of Total PCB
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
4+10
8+5
31+28
43+49
41+71+64
70+76
66+95
56+60
101
77+110
151
149
118
146
153+132+105
141
163+138
158
187+182
183
174
177
202+171
180
170+190
201
203+196
189
208+195
206

Figure 23.

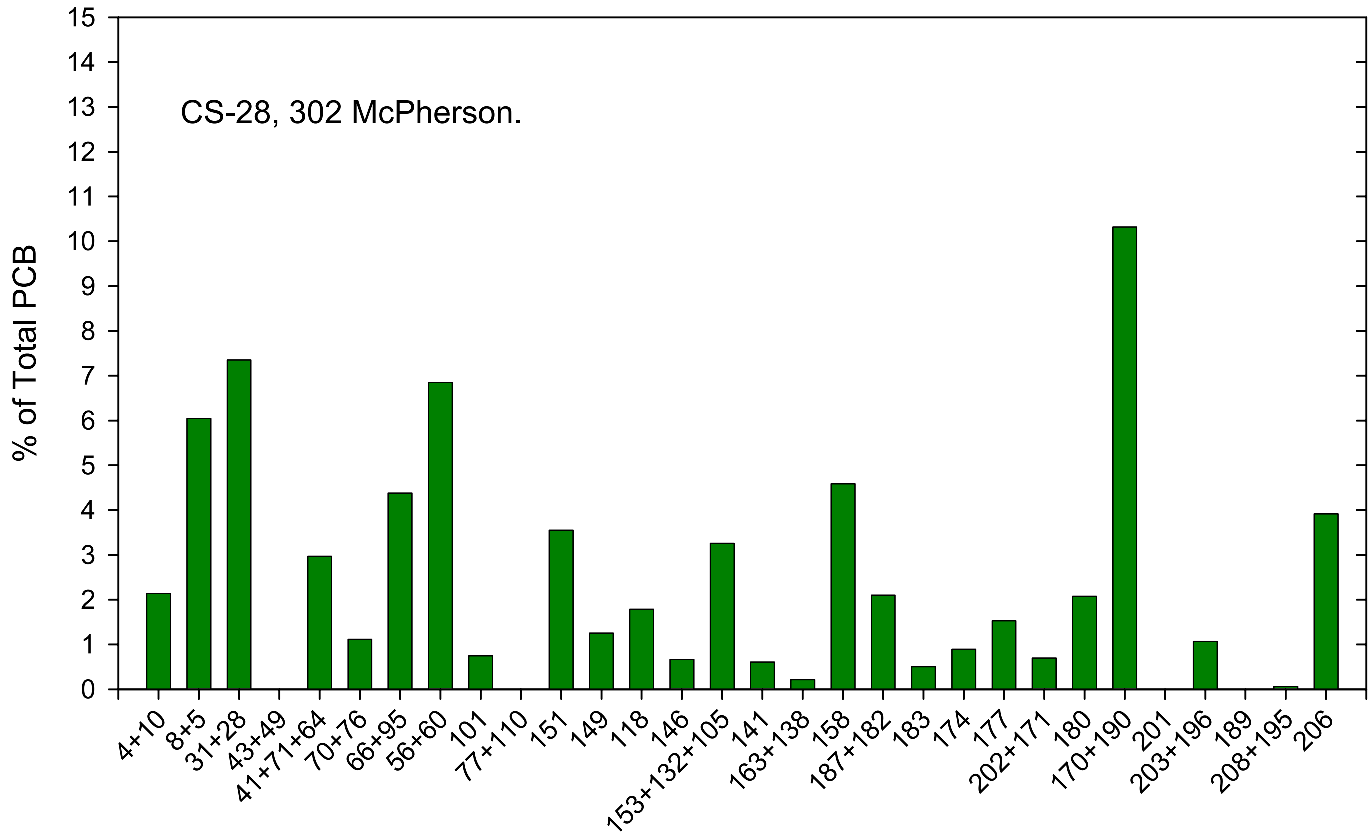

CS-28, 302 McPherson.
% of Total PCB
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
4+10
8+5
31+28
43+49
41+71+64
70+76
66+95
56+60
101
77+110
151
149
118
146
153+132+105
141
163+138
158
187+182
183
174
177
202+171
180
170+190
201
203+196
189
208+195
206

Figure 24.

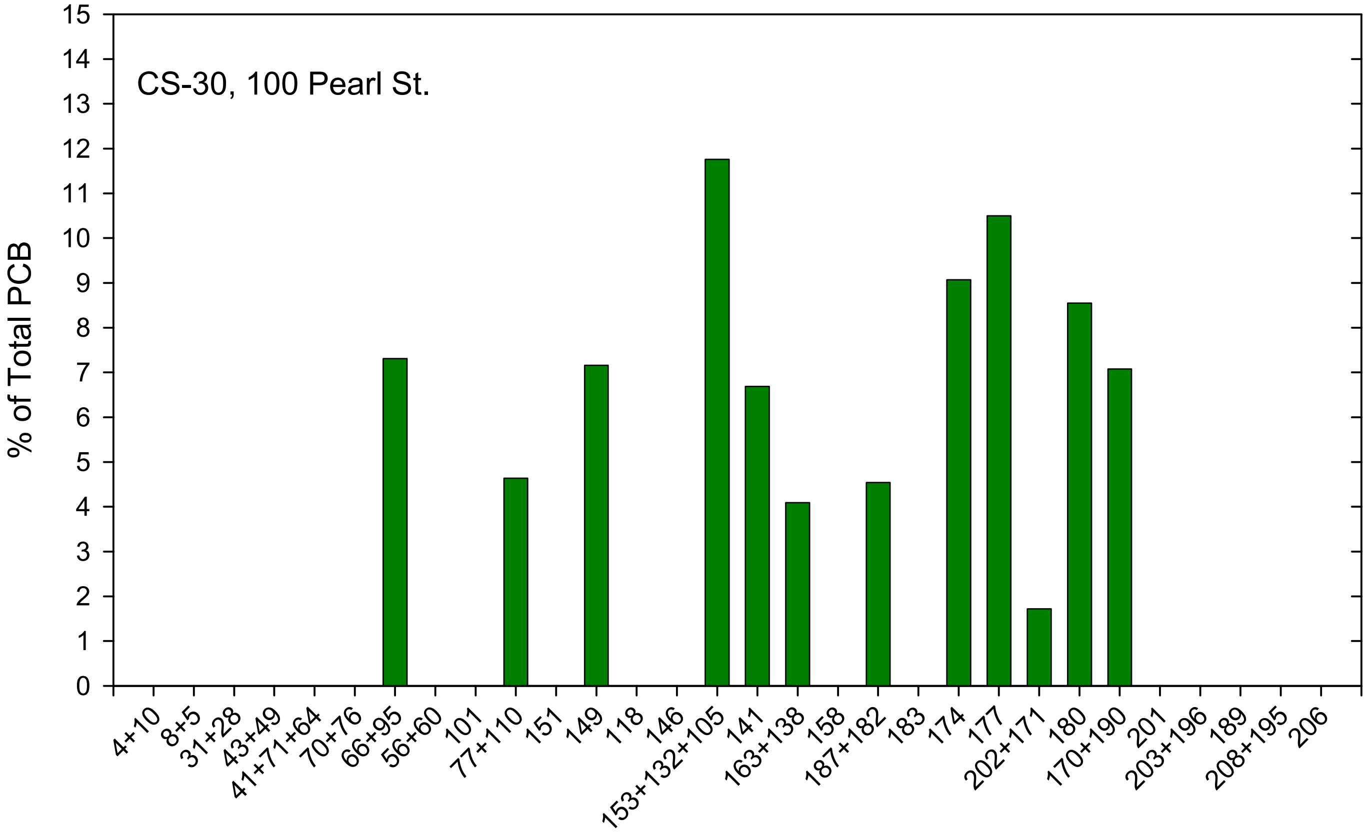

CS-30, 100 Pearl St.
% of Total PCB
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
4+10
8+5
31+28
43+49
41+71+64
70+76
66+95
56+60
101
77+110
151
149
118
146
153+132+105
141
163+138
158
187+182
183
174
177
202+171
180
170+190
201
203+196
189
208+195
206

Figure 25.

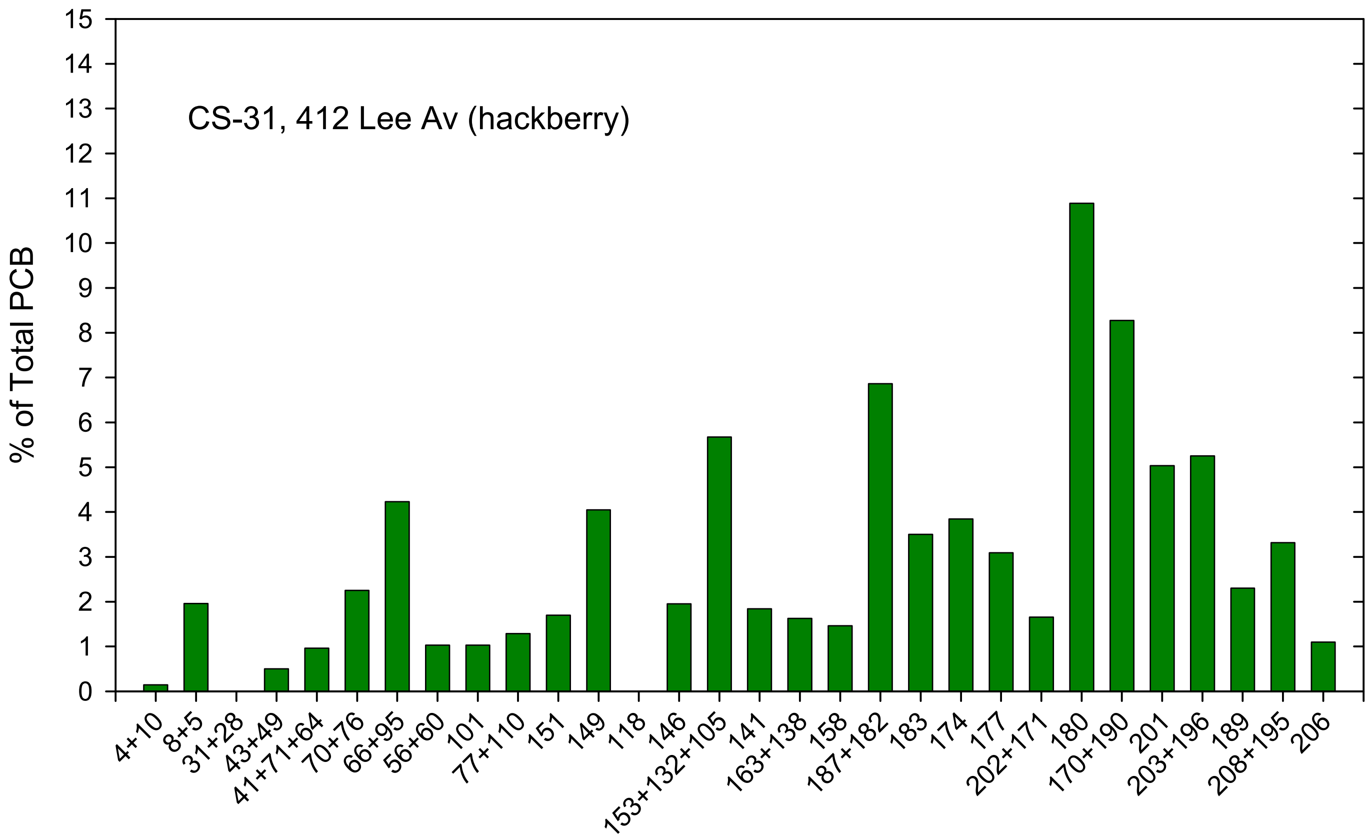
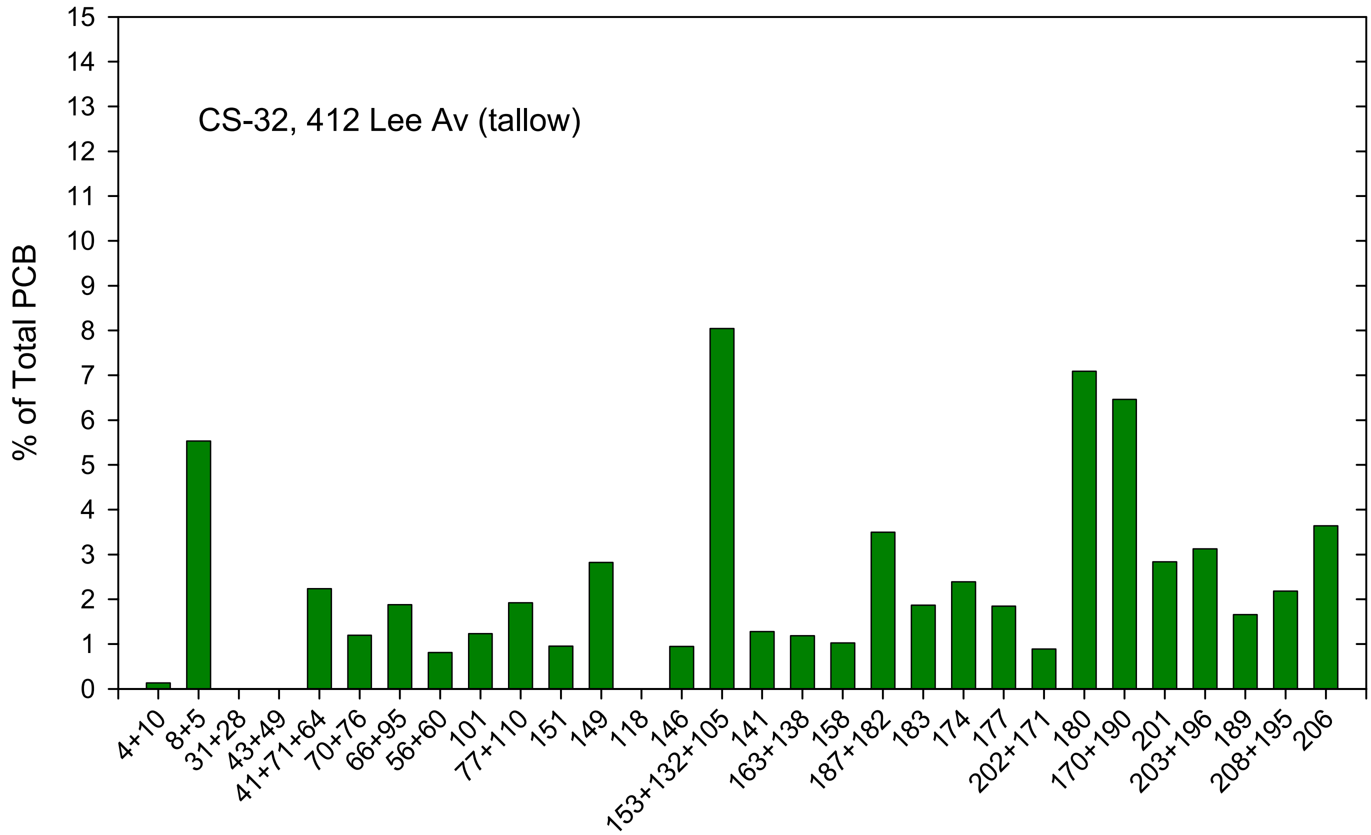

CS-31, 412 Lee Av (hackberry)
% of Total PCB
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
4+10
8+5
31+28
43+49
41+71+64
70+76
66+95
56+60
101
77+110
151
149
118
146
153+132+105
141
163+138
158
187+182
183
174
177
202+171
180
170+190
201
203+196
189
208+195
206

Figure 26.



CS-32, 412 Lee Av (tallow)
% of Total PCB
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
4+10
8+5
31+28
43+49
41+71+64
70+76
66+95
56+60
101
77+110
151
149
118
146
153+132+105
141
163+138
158
187+182
183
174
177
202+171
180
170+190
201
203+196
189
208+195
206

Figure 27.

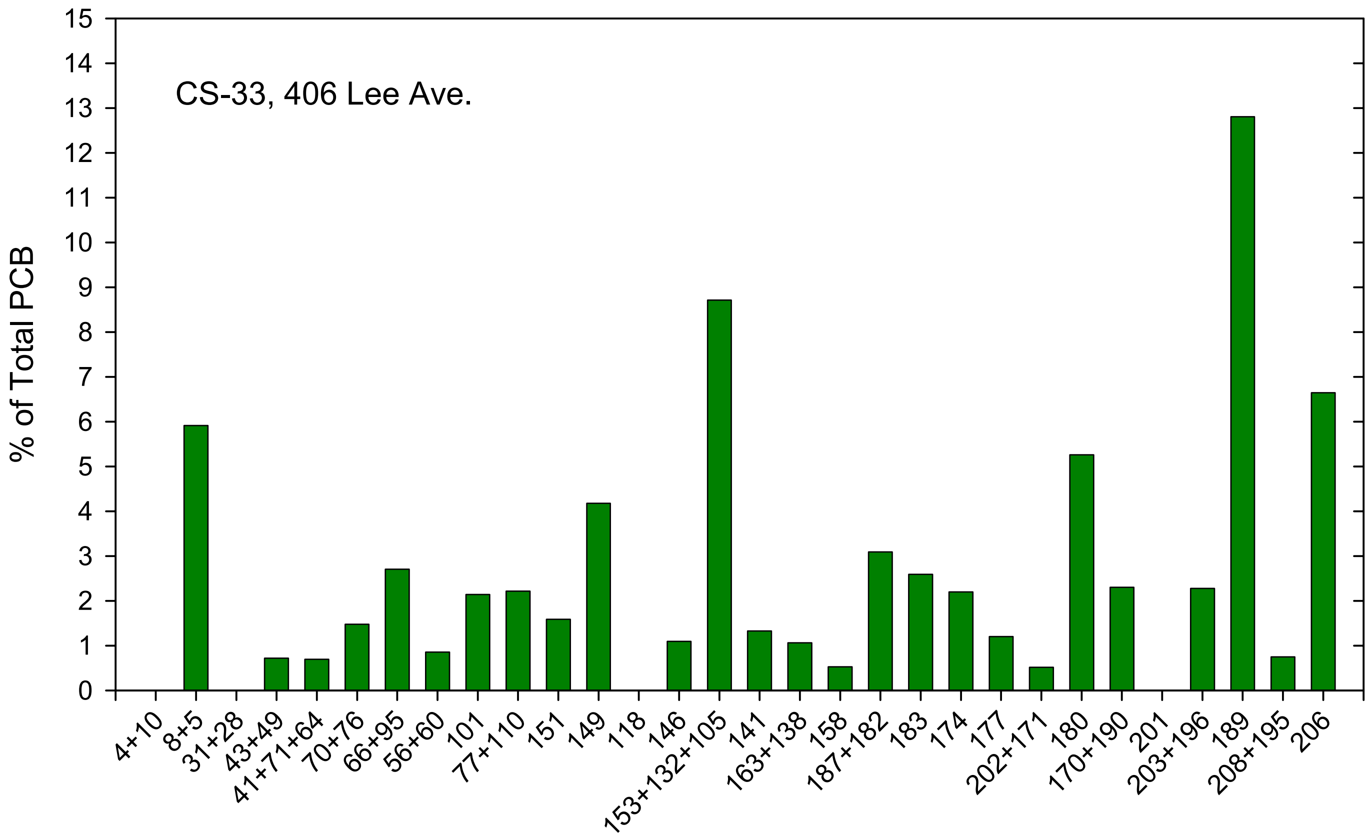

CS-33, 406 Lee Ave.
% of Total PCB
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
4+10
8+5
31+28
43+49
41+71+64
70+76
66+95
56+60
101
77+110
151
149
118
146
153+132+105
141
163+138
158
187+182
183
174
177
202+171
180
170+190
201
203+196
189
208+195
206

Figure 28.

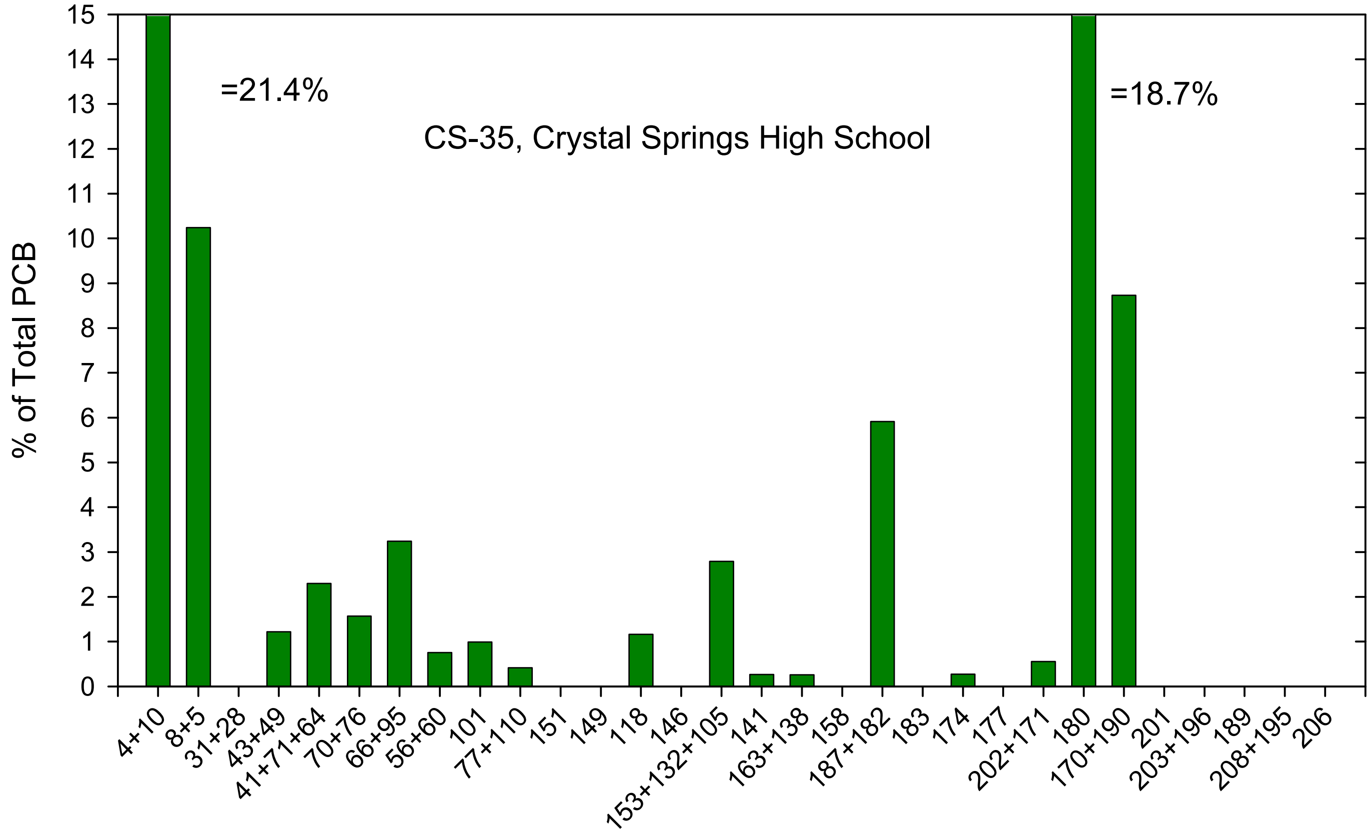

% of Total PCB
=21.4%
CS-35, Crystal Springs High School
=18.7%
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
4+10
8+5
31+28
43+49
41+71+64
70+76
66+95
56+60
101
77+110
151
149
118
146
153+132+105
141
163+138
158
187+182
183
174
177
202+171
180
170+190
201
203+196
189
208+195
206

Figure 29.

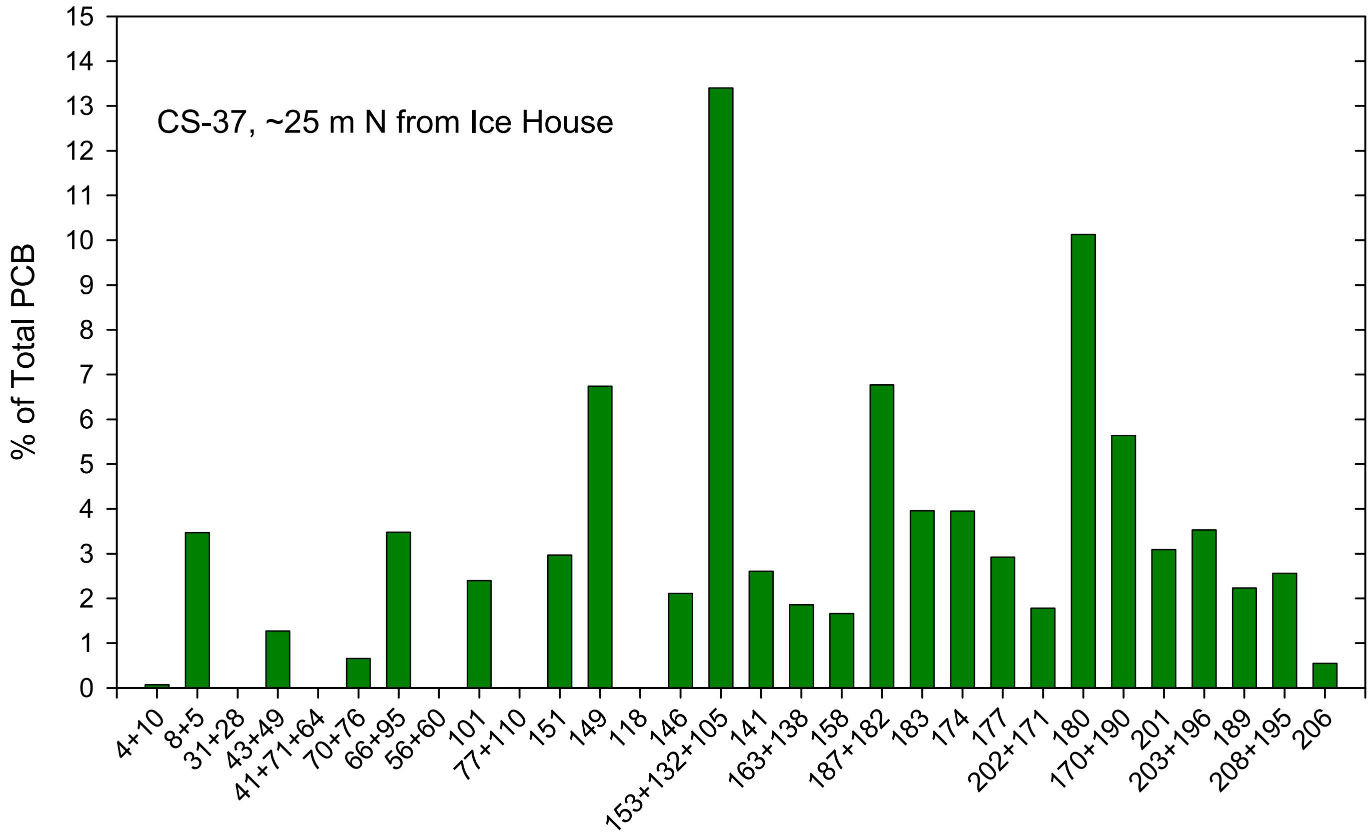
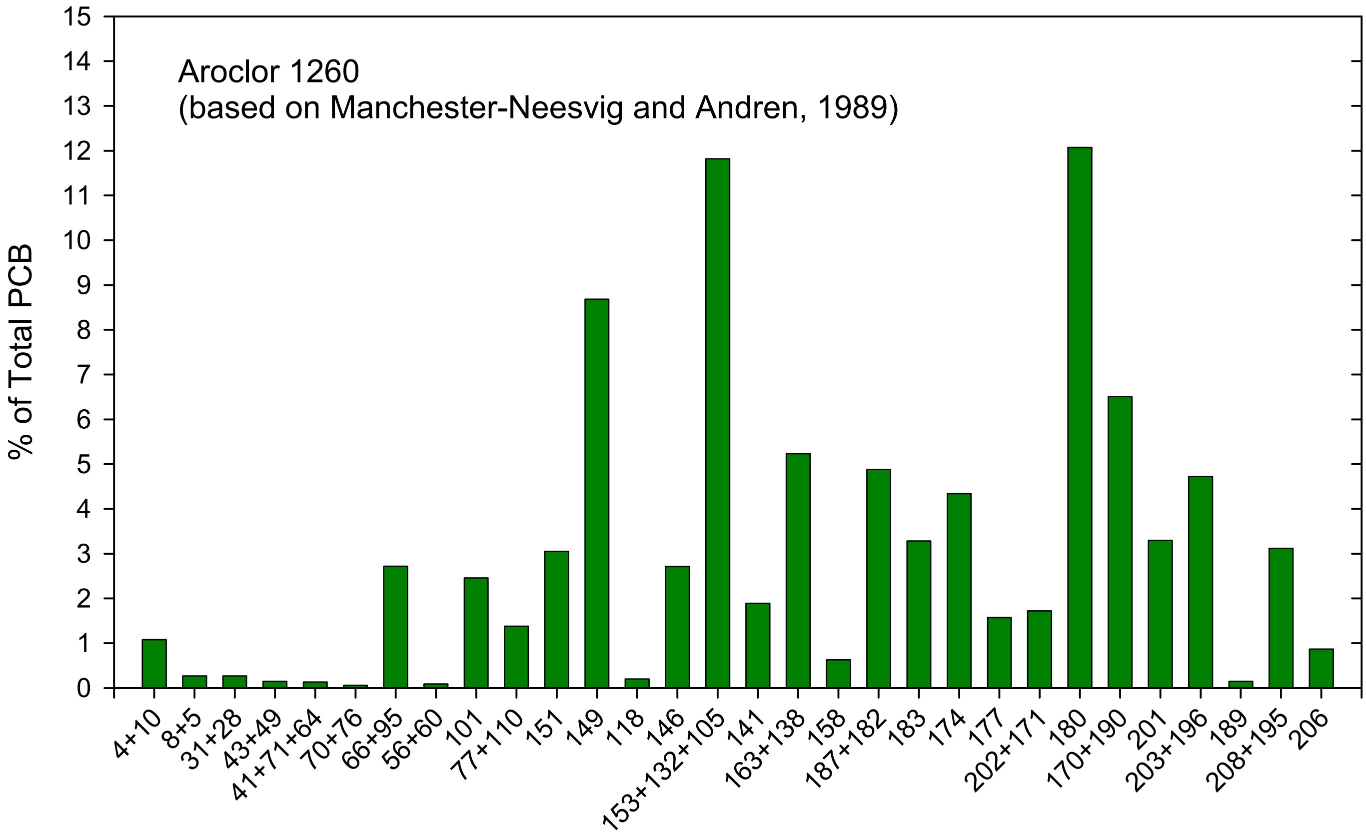

CS-37, ~25 m N from Ice House
% of Total PCB
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
4+10
8+5
31+28
43+49
41+71+64
70+76
66+95
56+60
101
77+110
151
149
118
146
153+132+105
141
163+138
158
187+182
183
174
177
202+171
180
170+190
201
203+196
189
208+195
206

Figure 30.



Aroclor 1260
(based on Manchester-Neesvig and Andren, 1989)
% of Total PCB
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
4+10
8+5
31+28
43+49
41+71+64
70+76
66+95
56+60
101
77+110
151
149
118
146
153+132+105
141
163+138
158
187+182
183
174
177
202+171
180
170+190
201
203+196
189
208+195
206

Figure 31