PCB 101

2016 Pacific Northwest Snowfighters Conference
June 8, 2016

Dave Hope,

Pacific Rim Laboratories Inc.

Outline

- Pacific Rim Laboratories Inc.
- PCB – what is it and why are we still interested in it
- Toxicity
- How do we analyze it – Analytical Methods
- What does PCB have to do with snow fighting?
- Closing thoughts

Who Am I?

- Analytical Chemist
  - P.Chem. – ACPBC
  - Past-President, Canadian Council of Independent Laboratories
  - Owner, Lab Director, Quality Assurance Officer, Pacific Rim Laboratories
- I am not
  - Toxicologist
  - Consultant

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My Business Partner and co-founder

- Patrick Pond
- Chief Technical Officer
- GC and HRMS instrument specialist

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Our Mission Statement

- To be the most diversified (niche) HRMS lab in North America

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Pacific Rim Laboratories Inc.

- Small ultra-trace organic laboratory specializing in the analysis of Persistent Organic Pollutants by High Resolution Mass Spectrometry
- Located in Surrey, BC (suburb of Vancouver, Canada)
- Accredited by WDOE and CALA for the analysis of PCB, PCDD/F, PBDE and other persistent organic pollutants (POPs).
- Work in the ppt, ppq and sub-ppq range

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Pacific Rim Laboratories Inc.
Scientific Research and Experimental Development

- We thrive on innovation
  - PBDE method in 2005
  - 209 congener PCBs in 2005
  - Sub-ppb PAH analysis food in 2006
  - First DFS HRMS in 2008
  - Published 2009 congener PCB by SGE HT8 column (2009)
  - Improved clean-up methods for dioxins/PCB (2014)
  - Single run PAH and alkylated PAH on TSQ8000Evo (2015)

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How small is small? mg, µg, ng, pg, fg, ag

pg/L or pg/kg = One part per quadrillion (10^{-15})

1. Lake Erie (one of the Great Lakes), 484 km^3
2. Add one pound (454 g)
3. Stir
4. One part per quadrillion

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How small is small? mg, µg, ng, pg, fg, ag

pg/L or pg/kg = One part per quadrillion (10^{-15})

- Canada is 10,000,000 km^2
- \$20 bill is 100 cm^2
- Drop the \$20 from an airplane and try to find it
- 1 part per quadrillion

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Polychlorinated Biphenyls (PCB)

- Manufactured until early 1970’s (1980’s in Eastern Europe)
  - Total production 1.3-1.5M Tonnes
  - Aroclor 1016, 1242, 1254, 1260
  - Kanaclor
- Byproduct in the manufacture of other chemicals
  - Copper sulphate from China contaminated with PCB126, 169 and 77.

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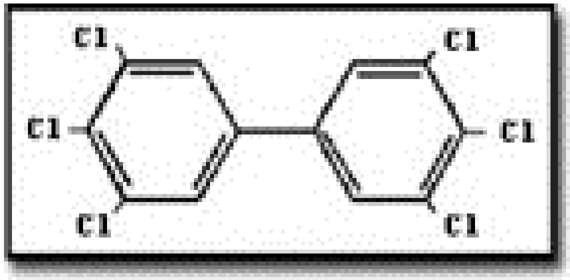
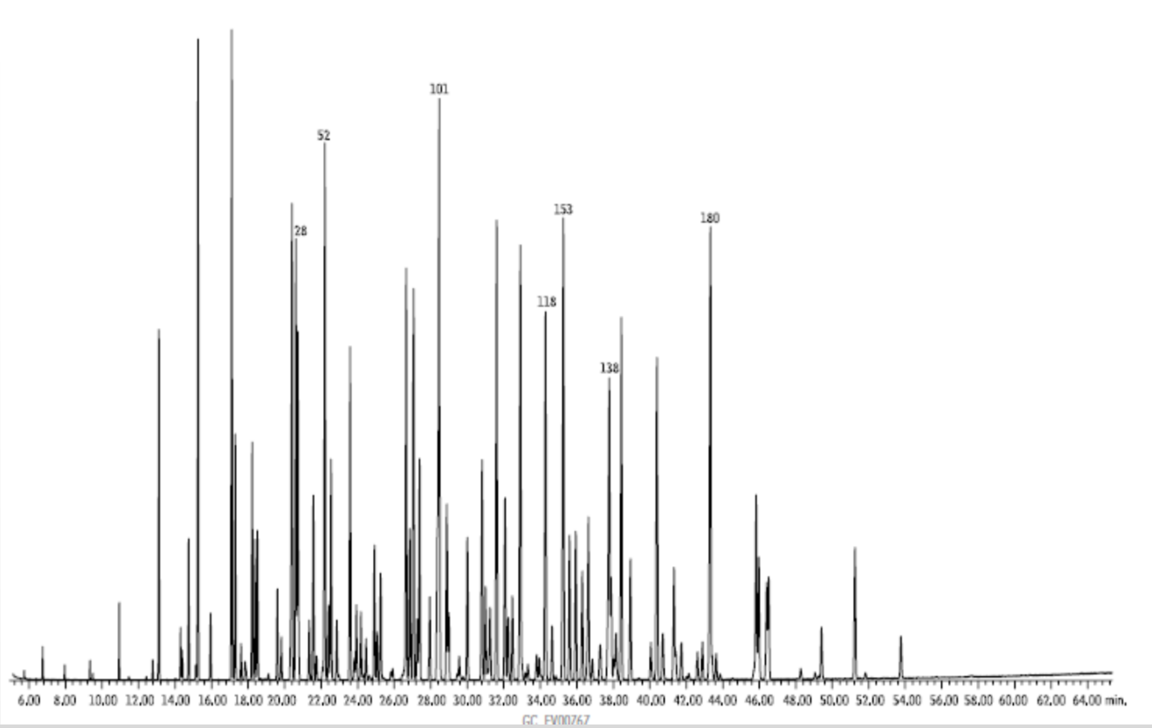
Chemical Structure



- 209 possible congeners – mono thru decachlorobiphenyl
- Twelve are considered dioxin like and have been assigned Toxic Equivalency Factors (TEF)

- MonoCB 3 congeners
- DiCB 12 congeners
- TriCB 24 congeners
- TetraCB 42 (2) congeners
- PentaCB 46 (5) congeners
- HexaCB 42 (4) congeners
- HeptaCB 24 (1) congeners
- OctaCB 12 congeners
- NonaCB 3 congeners
- DecaCB 1 congeners

PCBs on ECD – Mix of Aroclor 1242, 1254, 1260



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Global Production

Total global production of PCBs

Producer	Country	Start	Stop	Quantity (tons)
Monsanto	USA	1930	1977	641,246
Geneva Ind.	USA	1971	1973	454
Kanegafuchi	Japan	1954	1972	56,326
Mitsubishi	Japan	1969	1972	2,461
Bayer AG	West Germany	1930	1983	159,062
Prodelec	France	1930	1984	134,654
S.A. Cros	Spain	1955	1984	29,012
Monsanto	U.K.	1954	1977	66,542
Caffaro	Italy	1958	1983	31,092
Zaklady Azotowe	Poland	1974	1977	679
Electrochemical Co.	Poland	1966	1970	1,000
Chemko	Czechoslovakia	1959	1984	21,482
Orgsteklo	USSR (Russia)	1939	1990	141,800
Orgsintez	USSR (Russia)	1972	1993	32,000
–Xi'an	China	1960	1979	8,000
Total		**1930**	**1993**	**1,325,810**

Source: *Breivik, K. et al., "Towards a global historical emission inventory for selected PCB congeners - A mass balance approach", 2007*

- 48% produced in USA
- 50% of remaining production imported to USA
- 97% in Northern Hemi

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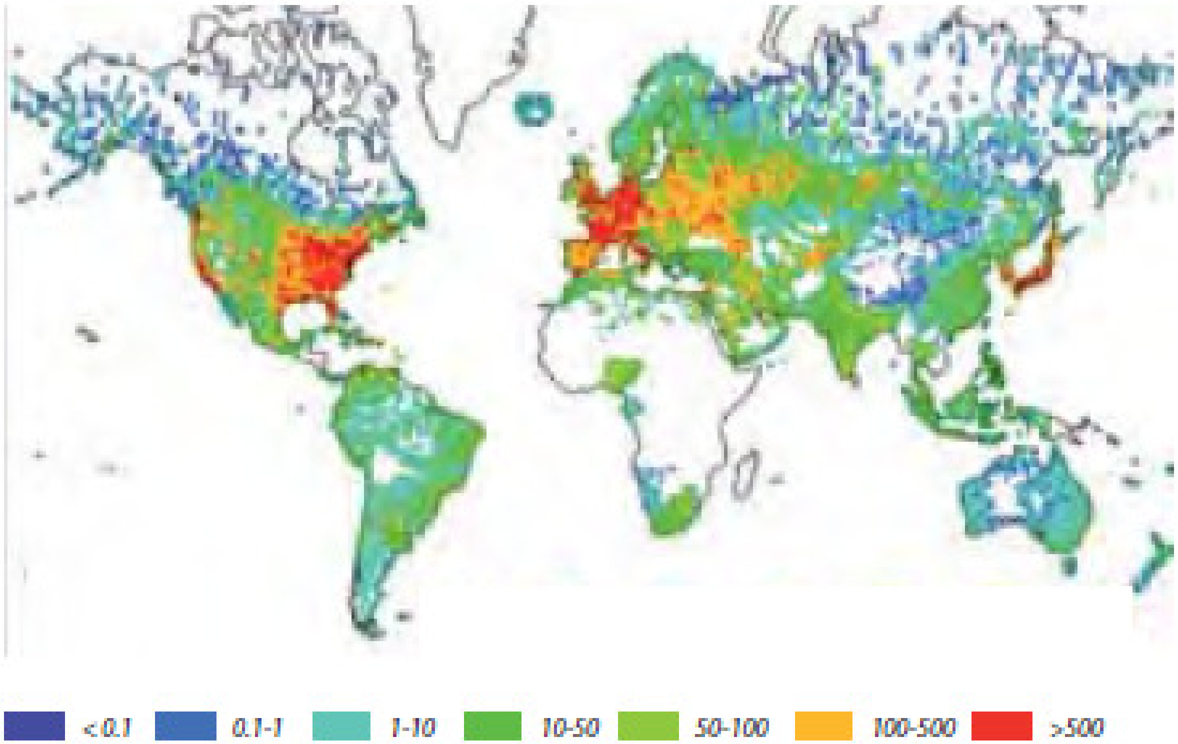
Estimated cumulative global usage of PCBs (legends in t) with 1°x1° longitude and latitude resolution



Source: *Breivik, K. et al., "Towards a global historical emission inventory for selected PCB congeners - a mass balance approach", 2002*

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Applications of PCB

- **Closed systems**
- Insulation and/or cooling fluid in transformers (48%)
- Dielectric fluid in capacitors (21%)
- Switches
- **Partially open systems**
- Heat transfer fluids
- Hydraulic fluid in lifting equipment, trucks and high pressure pumps
- Vacuum Pumps
- Voltage Regulators
- Liquid Filled Electrical Cables
- Liquid Filled Circuit Breakers

- **Open systems (21%)**
- Paints
- Lubricating fluid in oils and grease
- Water-repellent impregnating agent and fire retardant for wood, paper, fabric and leather
- Laminating agent in paper production
- Additive in glues, sealants and corrosion protection coatings
- Carrier for insecticides
- Polymerisation catalyst support for petrochemicals
- Immersion oils for microscopy
- Pesticide Formulation
- Cable coatings/casings

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Highest levels of PCBs reported for various open uses.

Material	Bulk Sample (mg/kg or ppm)	Material	Bulk Sample (mg/kg or ppm)
Adhesive tape	1,400	Foam rubber parts	1,092
Carbonless Copy Paper	6,000	Grout	9,100
Caulking	310,000	Insulating materials in electric cable	280,000
Ceiling tiles	53	Plastics/plasticisers	13,000
Cloth/paper insulating material	12,000	Ventilation system cork gasket material	6,400
Coal-tar enamel coatings	1,264	Roofing/siding material	22,000
Dried paint	97,000	Rubber parts	84,000
Fiberglass insulation	39,158	Thermal insulation	73,000
Foam rubber insulation	13,100	Wool felt gaskets	688,498

Source: *Use Authorization for and Distribution in Commerce of Non-Liquid Polychlorinated Biphenyls. US Federal Register, 1999*

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What are POPs – Stockholm Convention

- Ratified in 2001, came into force in 2004
  - Canada was the first country to ratify the treaty on 23 May 2001
- There are 179 parties to the Convention - does not include USA, Italy
- Industrial By-products - Dioxin, Furans, Hexachlorobenzene (HCB)
- Man made - Pesticides – Aldrin, Dieldrin, Endrin, Chlordane, DDT, Heptachlor, Mirex, Toxaphene; **PCB**; HCB
- Added in 2009 - α-HCH, β-HCH, γ-HCH (Lindane); PBDE (47, 99, 153, 154, 175/183) Flame retardant; Pentachlorobenzene; Chlordecone (similar to Mirex); Hexabromobiphenyl (PBB153); PFOS/PFOA; PCP; PCN; Endosulphan

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PCB Toxicity

- World Health Organization (WHO) defines twelve toxic congeners
  - Due to positioning of chlorines, the molecule is unable to rotate and forms structure similar to dioxin
- 2,3,7,8-TCDD considered to have a toxicity of 1, all others are relative to TCDD
- Toxic Equivalency Factors (TEF)
  - PCB126 (0.1), PCB169 (0.03), PCB077 (0.0001), PCB081 (0.0003)
  - PCB105, 114, 118, 123, 156, 157, 167, 189 (0.00003)
- PCB TEQ = $\sum C_x \times TEF_x$ for all PCB congeners

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Regulatory Levels – Food
Max intake – 2 pg TEQ/kg bw/day

European Food Regulations (pg WHO-TEQ/g fat)

	PCDD/F	(&PCB)
Fish (fresh wt):	4	(8)
Pork:	1	(1.5)
Poultry	2	(4)
Beef / mutton:	3	(4.5)
Liver	6	(12)
Milk:	3	(6)
Eggs:	3	(6)
Vegetable oil:	0.75	(1.5)
Mix Animal fat:	2	(3)
Fish oil:	2	(10)

European Feed Regulations

Feed*:	0.75 pg WHO-TEQ/g
Pet foods:	2.25 pg WHO-TEQ/g
Animal fat:	2 pg WHO-TEQ/g
Minerals:	1 pg WHO-TEQ/g
Fish oil:	6 pg WHO-TEQ/g
Fish meal:	1.25 pg WHO-TEQ/g

- * - based on 12% moisture content

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Food levels

- Eggs – 2.1-38 ug/kg fat
  - 0.11 – 2.86 ng TEQ/kg fat
- Meat – 50 – 1960 ng/kg fat
  - 0.001 – 0.182 ng TEQ/kg fat
- Fish 0.29 – 87 ug/kg
  - 0.1 – 2.4 ng TEQ/kg

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Fish sample – Cl_4-Cl_7

Fish sample – Cl_7-Cl_{10}

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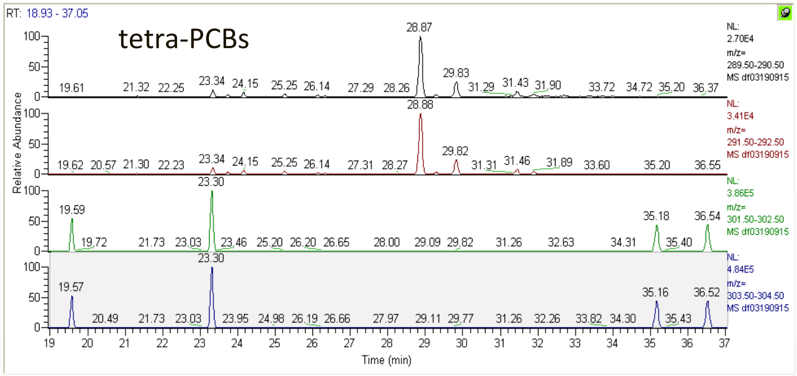
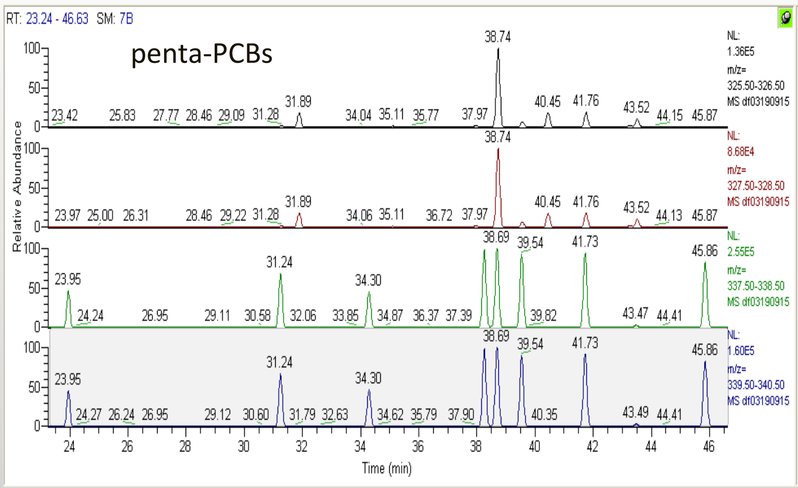
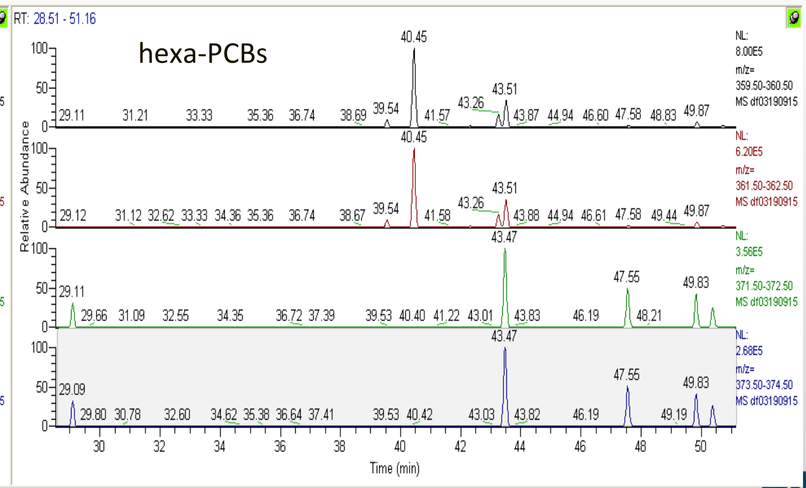
PCB Analysis in Blood







- PCBs in blood
  - 200-800 ug /kg lipid
  - PCB153>138>180>187>118>170>99

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Analytical Methods
Good – Better - Best

- GC/ECD Methods
    - EPA 8081, 8082, 608, 508
- GC/MS Methods
    - EPA 8270
- GC/HRMS Methods
    - EPA 1668

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Analytes
Good – Better - Best

- Total PCB – Aroclor equivalents
- Homolog Totals
    - 10 levels of chlorination
- Congener specific (209)

Quantitation Methods
Good – Better - Best

- External standard
  - compare with calibration curve
  - Requires known final volume and amount injected
- Internal Standard
  - Add standard just before analysis
  - Relative response factors determined from calibration curve
  - With area of IS peak and RRF, can calculate concentration
- Isotope dilution
  - Stable isotopes added before extraction used to quantify results
  - Corrects for loses during work-up

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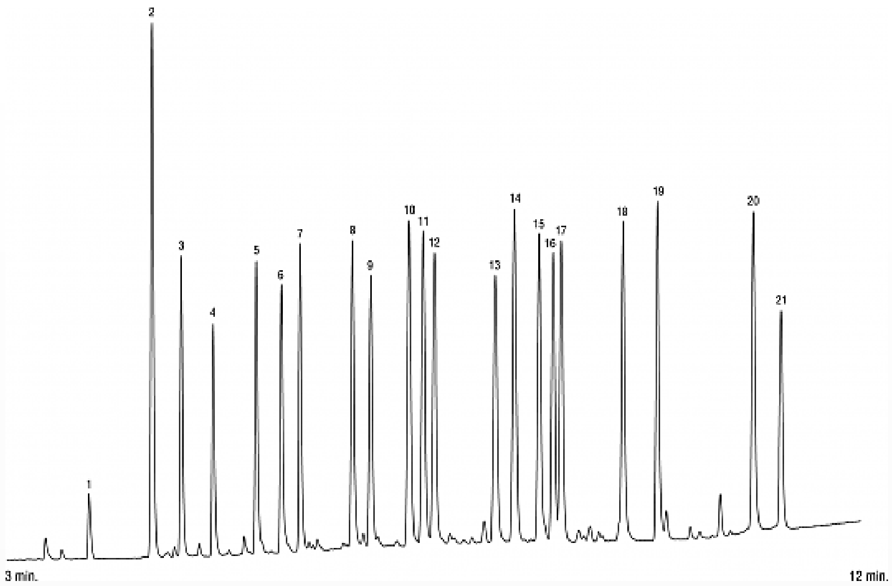
EPA 8082



- Can be used to identify Aroclors or congeners
- 19 congeners – MonoCB – NonaCB
- PCB1, 15, 18, 31, 44, 52, 66, 87, 101, 110, 138, 141, 151, 153, 170, 180, 183, 187, 206
- IS Method: One internal standard and one surrogate standard

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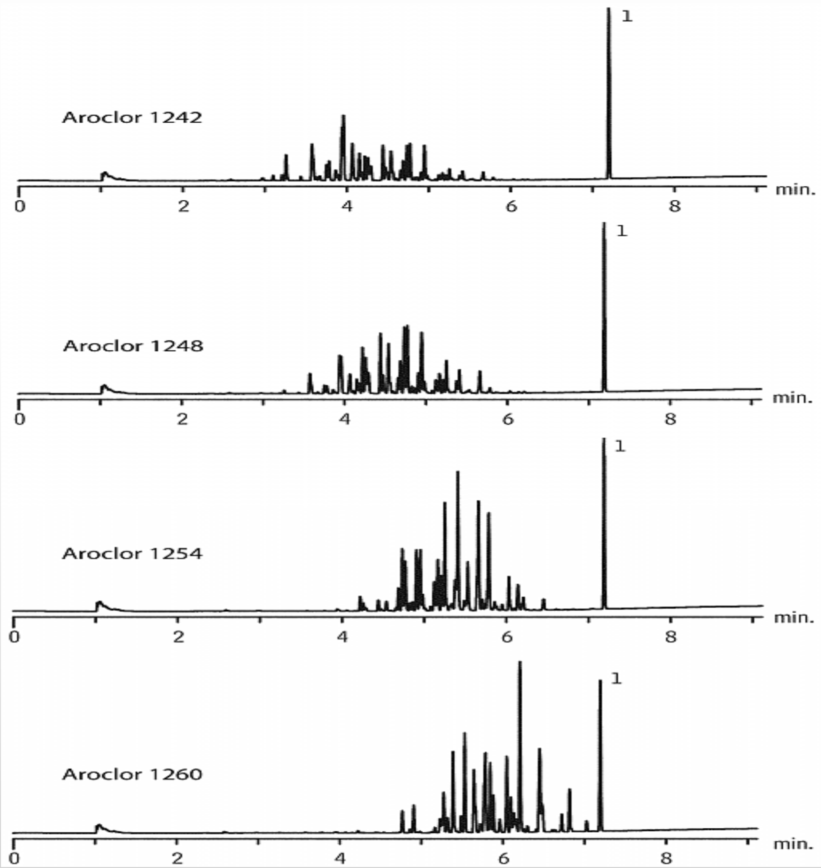
Pattern Recognition



- Must match the pattern in the sample with one of 7 Aroclor standards
- Use 3-5 peaks in the standard to quantify sample (External Std)
- Detection limits 0.05 ug/L
- Problems with pattern recognition in weathered samples

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GC/MS Methods

- EPA 8270
  - Generic catch-all method
  - Uses GC/MS for ultimate identification, but causes a greatly reduced sensitivity (increased detection limit)
  - Detection limits 10 ug/L (Aroclor equivalents)
- Homolog Total Methods
  - Uses GC/MS in SIM for greater sensitivity and selectivity
  - Internal Standard for each level of chlorination
  - PCB defined as having peaks in QM and RM channels and being within 15% of theoretical mass ratio
  - Quantifies on congener basis but not identified
  - Detection limits 0.001 ug/L on a congener basis

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EPA Method 1668

- HRGC-HRMS congener specific method (first written 1999, revised in November 2008, June 2010)
- Uses 27 internal standards ($^{13}C_{12}$-labeled congeners)
  - All twelve dioxin-like PCBs
  - First and last eluters in each level of chlorination (LOC)
  - Three $^{13}C_{12}$-clean-up standards and five $^{13}C_{12}$-recovery standards
- Five (1-2000 ng/mL) or six point (0.2-2000 ng/mL) calibration for dlPCBs and LOC PCBs
- Single point calibration for all remaining PCBs
- Two methods of quantification
  - Isotope dilution (for 27 congeners with labeled standards)
  - Internal standard – everything else

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HRMS analysis - Issues

- Coelutions for TeCB, PeCB and HxCB
  - M-Cl gives significant peak, therefore cannot have coelutions with significant peaks of higher LOC
- Each LOC requires four ions
  - PeCB, HxCB, HpCB and OcCB overlap
  - Requires 16 ion channels
- Need to maximize sensitivity, therefore typical collection rates of 1 hz (no 10-100 hz that can be found with ECDs or MSDs)

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Results

- 209 resolvable by ECD @ 100 hz
- 189 resolvable peak tops by HRMS
- 37/42 TeCB
- 37/46 PeCB
- 40/42 HxCB

Congen Number	9 Pt Std	CS209
PCB-001	10.44	10.29
PCB-002	13.02	12.94
PCB-003	13.30	13.23
PCB-010	14.18	14.04
PCB-004	14.29	14.22
PCB-009	16.35	16.31
PCB-007	16.60	16.49
PCB-006	17.78	17.76
PCB-008	18.31	
PCB-005	18.39	18.30
PCB-014	19.95	19.88
PCB-011	22.45	22.47
PCB-013	23.17	
PCB-012	23.19	23.16
PCB-015	46.47	23.96
PCB-019	19.56	19.50
PCB-030	20.41	20.38
PCB-018	22.27	22.25
PCB-017	22.67	22.61
PCB-024	23.24	23.21
PCB-027	23.75	23.73
PCB-032	24.66	24.62
PCB-016	24.90	24.88
PCB-023	25.95	25.95
PCB-034	26.41	26.39
PCB-029	26.61	26.59
PCB-026	27.56	27.54
PCB-025	27.99	27.98
PCB-031	28.50	28.49
PCB-028	29.03	29.03
PCB-021	29.98	29.99
PCB-020	30.55	
PCB-033	30.59	30.56
PCB-022	31.49	31.51
PCB-036	32.70	32.73
PCB-039	33.78	33.85
PCB-038	35.41	35.43
PCB-035	37.36	37.43
PCB-037	38.64	38.72

Congen Number	9 Pt Std	CS209
PCB-054	25.37	25.37
PCB-050	27.37	27.35
PCB-053	28.95	28.98
PCB-051	29.71	29.73
PCB-045	30.56	30.56
PCB-046	32.09	32.09
PCB-069	32.90	
PCB-052	33.01	33.01
PCB-073	33.27	33.31
PCB-043	33.45	
PCB-049	33.68	33.68
PCB-065	33.95	
PCB-075	34.23	33.94
PCB-062	34.39	34.27
PCB-048	34.35	
PCB-047	34.40	34.38
PCB-044	36.33	36.35
PCB-059	36.56	36.59
PCB-042	36.98	36.99
PCB-064	37.85	
PCB-072	38.27	37.86
PCB-071	38.28	38.18
PCB-041	38.37	38.33
PCB-068	39.08	39.11
PCB-040	39.81	39.83
PCB-057	40.37	40.40
PCB-067	41.32	41.35
PCB-063	41.69	41.73
PCB-058	41.92	41.93
PCB-061	42.18	42.20
PCB-074	42.73	42.78
PCB-070	43.54	43.59
PCB-055	43.78	43.78
PCB-066	44.36	44.39
PCB-080	44.37	44.49
PCB-076	45.58	45.61
PCB-060	46.94	47.00
PCB-056	47.22	47.26
PCB-079	49.75	49.84
PCB-078	51.27	51.36
PCB-081	52.51	52.59
PCB-077	54.16	54.20

Congen Number	9 Pt Std	CS209
PCB-104	33.92	33.90
PCB-096	37.12	37.15
PCB-103	38.48	38.50
PCB-100	39.55	39.55
PCB-094	40.55	40.59
PCB-093	41.75	
PCB-102	41.89	
PCB-098	41.96	
PCB-095	42.11	41.81
PCB-088	42.55	42.59
PCB-091	43.15	43.15
PCB-121	43.69	43.73
PCB-084	45.76	45.80
PCB-092	45.98	45.99
PCB-089	46.18	46.22
PCB-090	46.84	46.88
PCB-101	47.17	47.19
PCB-113	47.65	47.68
PCB-099	48.10	48.12
PCB-112	49.10	
PCB-119	49.34	49.12
PCB-083	49.59	49.72
PCB-109	49.73	49.72
PCB-086	50.31	
PCB-125	50.43	
PCB-117	50.48	50.48
PCB-097	50.63	
PCB-116	50.87	50.91
PCB-115	51.11	
PCB-087	51.19	51.16
PCB-111	51.78	51.89
PCB-085	51.91	51.99
PCB-110	52.60	52.65
PCB-120	52.68	52.73
PCB-082	54.02	54.05
PCB-124	55.49	55.51
PCB-108	55.81	
PCB-107	55.84	55.86
PCB-123	56.14	56.15
PCB-106	56.28	56.30
PCB-118	56.59	56.61
PCB-114	57.27	57.29
PCB-122	57.87	57.91
PCB-105	59.08	59.09
PCB-127	59.26	59.28
PCB-126	61.33	61.36

Congen Number	9 Pt Std	CS209
PCB-155	43.35	43.37
PCB-150	46.70	46.70
PCB-152	47.77	47.77
PCB-145	50.01	48.99
PCB-136	50.05	50.06
PCB-148	50.58	50.58
PCB-154	51.88	51.89
PCB-151	52.99	52.99
PCB-135	53.51	53.52
PCB-144	53.73	53.87
PCB-147	53.80	53.81
PCB-149	54.56	
PCB-139	54.59	54.59
PCB-140	55.08	55.10
PCB-143	55.41	55.43
PCB-134	55.61	55.63
PCB-142	56.03	56.02
PCB-131	56.25	56.27
PCB-133	56.70	56.70
PCB-165	57.25	57.25
PCB-132	57.45	57.50
PCB-146	57.50	57.50
PCB-161	57.78	57.78
PCB-153	58.29	58.32
PCB-168	58.39	58.39
PCB-141	59.06	59.08
PCB-137	59.51	59.52
PCB-130	59.70	59.70
PCB-163	60.06	
PCB-164	60.07	60.08
PCB-138	60.19	60.21
PCB-160	60.21	60.31
PCB-158	60.37	60.39
PCB-129	60.53	60.53
PCB-166	60.79	60.79
PCB-159	61.47	61.49
PCB-128	61.59	61.61
PCB-162	61.74	61.76
PCB-167	62.09	62.09
PCB-156	62.98	62.97
PCB-157	63.17	63.17
PCB-169	64.43	64.46

Congen Number	9 Pt Std	CS209
PCB-188	55.30	55.31
PCB-184	56.25	56.27
PCB-179	57.48	57.50
PCB-176	58.31	58.31
PCB-186	58.91	58.93
PCB-178	59.98	60.00
PCB-175	60.39	60.41
PCB-182	60.54	
PCB-187	60.56	60.56
PCB-183	60.94	60.95
PCB-185	61.38	61.38
PCB-174	61.66	61.66
PCB-181	61.74	61.74
PCB-177	61.90	61.89
PCB-171	62.19	62.20
PCB-173	62.40	62.40
PCB-172	62.99	62.99
PCB-192	63.13	63.14
PCB-180	63.32	63.35
PCB-193	63.35	63.45
PCB-191	63.55	63.57
PCB-170	64.24	64.24
PCB-190	64.35	64.38
PCB-189	65.67	65.68
PCB-202	61.42	61.45
PCB-200	61.85	61.87
PCB-204	61.97	61.97
PCB-197	62.26	62.27
PCB-201	62.79	62.81
PCB-198	64.05	64.08
PCB-199	64.10	64.13
PCB-196	64.37	64.39
PCB-203	64.41	64.43
PCB-195	65.37	65.36
PCB-194	66.60	66.60
PCB-205	66.96	66.95
PCB-208	64.69	64.72
PCB-207	65.04	65.05
PCB-206	67.59	67.59
PCB-209	68.05	68.05

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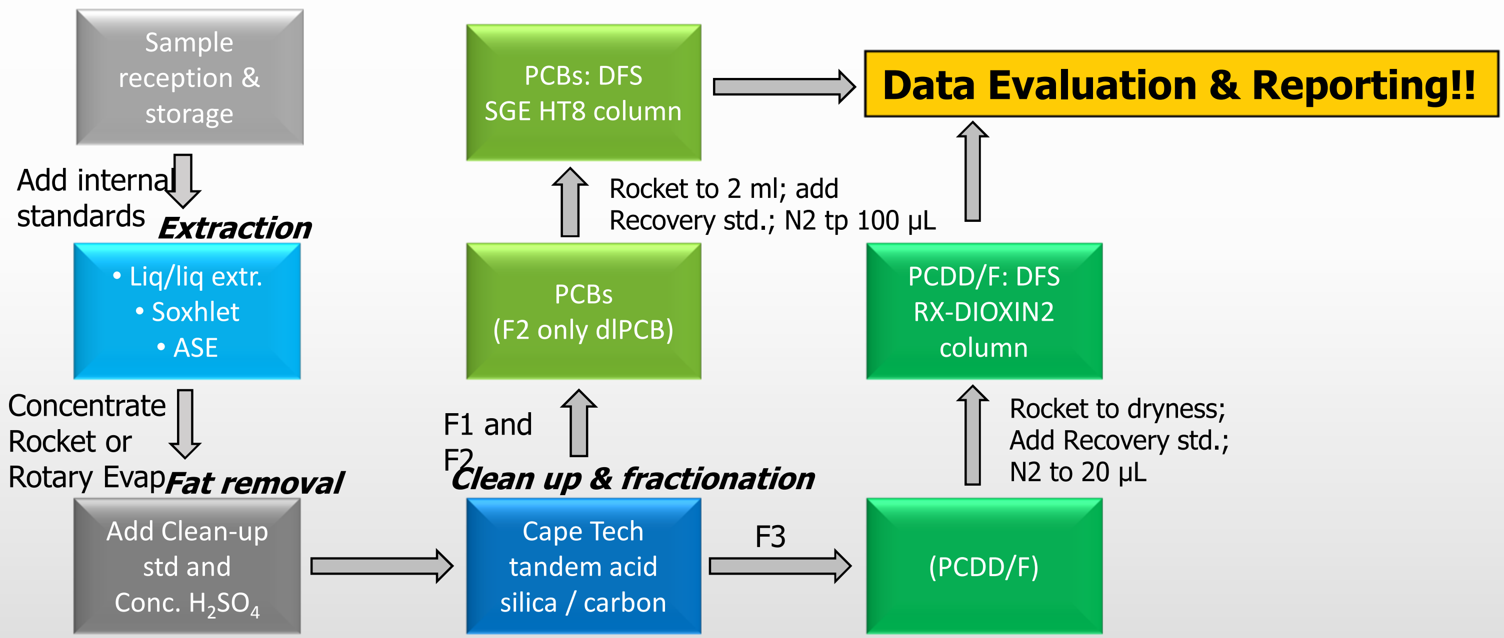
Analytical Workflow – Dioxin/PCB



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What is the Detection Limit?

- Standard methods for MDL determination
  - 7-10 blank samples spiked at low level with analytes of interest
  - MDL = 3 * SD (approximately)
  - Better precision leads to low MDLs
  - Our MDLs are 1-13 pg/L
- Isotope dilution allows for lower theoretical MDLs due to lower SD
- Many isotope dilution methods call for the reporting of Instrument Detection Limits based on 2.5 x SN
- Can give IDLs <1 pg/L

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What is Total PCB?

- Sounds simple, add up individual results for all 209 congeners
- How do you handle different detection limits? Co-elutions? Low level concentrations?
- Should data be reported below EQL?

Total PCB when DL set to 10 pg/L

PCB #	A	B	C	D	E	Blank
Homologs	pg/L	pg/L	pg/L	pg/L	pg/L	pg/L
Monochlorobiphenyls	10.8	10	12.3	10.7	11	0
Dichlorobiphenyls	19.6	74.6	50.5	52	14.4	0
Trichlorobiphenyls	63	12.6	0	11.3	0	0
Tetrachlorobiphenyls	101	0	10.4	0	0	0
Pentachlorobiphenyls	152	23.2	15.5	27.6	0	29.9
Hexachlorobiphenyls	69.2	0	0	0	0	0
Heptachlorobiphenyls	0	0	0	0	0	0
Octachlorobiphenyls	0	0	0	0	0	0
Nonachlorobiphenyls	0	0	0	0	0	0
Decachlorobiphenyl	0	0	0	0	0	0
Total PCB	**415**	**110**	**88.7**	**102**	**25.4**	**29.9**

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PCB #	A	B	C	D	E	Blank
Homologs	pg/L	pg/L	pg/L	pg/L	pg/L	pg/L
Monochlorobiphenyls	14.5	18.7	18.5	20.1	17.6	9.3
Dichlorobiphenyls	19.6	86.1	50.5	52	14.4	0
Trichlorobiphenyls	88.2	42.5	31.5	36	34.7	0
Tetrachlorobiphenyls	132.8	29.5	33.6	37.7	24.4	0
Pentachlorobiphenyls	173.4	40.2	24	27.6	15.5	29.9
Hexachlorobiphenyls	119.3	9.2	14.5	4.6	5.6	1.8
Heptachlorobiphenyls	30.2	0	0	0	2.3	0
Octachlorobiphenyls	11.6	0	2.5	0	1.4	0
Nonachlorobiphenyls	0	0	0	0	0	0
Decachlorobiphenyl	4.4	0	0	0	0	0
Total PCB	**594**	**226.2**	**175.1**	**178**	**115.9**	**41**

PCB #	A	B	C	D	E	Blank
Homologs	pg/L	pg/L	pg/L	pg/L	pg/L	pg/L
Monochlorobiphenyls	10.8	10	12.3	10.7	11	0
Dichlorobiphenyls	19.6	74.6	50.5	52	14.4	0
Trichlorobiphenyls	63	12.6	0	11.3	0	0
Tetrachlorobiphenyls	101	0	10.4	0	0	0
Pentachlorobiphenyls	152	23.2	15.5	27.6	0	29.9
Hexachlorobiphenyls	69.2	0	0	0	0	0
Heptachlorobiphenyls	0	0	0	0	0	0
Octachlorobiphenyls	0	0	0	0	0	0
Nonachlorobiphenyls	0	0	0	0	0	0
Decachlorobiphenyl	0	0	0	0	0	0
Total PCB	**415**	**110**	**88.7**	**102**	**25.4**	**29.9**

Now the results have been reported when IDLs have been used

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What is Blank?

- PCB is omnipresent
- Almost impossible to achieve a complete blank in the lab
- Every sample we analyze has detectable PCB levels.
- In order to reduce blank levels in the lab
  - Use carbon filtered water
  - Disposable glassware (not always possible)
  - Keep food samples away!
- <20 pg/L per congener is excellent

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Outline

- Pacific Rim Laboratories Inc.
- PCB – what is it and why are we still interested in it
- Toxicity
- How do we analyze it – Analytical Methods
- What does PCB have to do with snow fighting?
- Closing thoughts

City of Spokane – unique or just the leading edge?

- Current WA water quality regulations
  - PCB concentrations <170 pg/L
  - Based on fish consumption of 1-2 meals per month
- Spokane River major source of food for native Americans
  - Daily consumption for many therefore increased potential harm from fish
- Recommend acceptable levels <6 pg/L
- Spokane City passed an ordinance restricting purchasing to PCB free products.
  - Is this even possible

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How does PCB get into De-Icer Fluids?

- Not naturally abundant in $MgCl_2$ or NaCl.
- Possible source is from storage in plastics
  - Plastics contain trace levels of PCBs
  - These can be transferred to brine during storage
- Additional chemicals need to be checked to make sure they are PCB free
- Are PCBs present or are they artifacts of the analysis?

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Present in sample or lab contamination?

- What is the detection limit of the method?
- What are the concentrations found in the method blank?
- Concentrations below the EQL are suspect.
    - EQL is based on the lowest standard in the calibration curve (0.2 pg/µL injected)
    - For 1 L sample with 100 µL final volume
        - EQL = 0.2 pg/ µL x 100 µL / 1 L = 20 pg/L or 0.02 ng/L
- Most confidence when results are 5-10 x EQL

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What is being found?

- Most results for brine solutions are <1 ng/L and within a factor of 5 of blank concentrations
- If you are testing product, discuss it with your testing lab first.
  - Will help you with clean sample containers and advice on how to sample
- Data interpretation is not straight forward.
  - Blank contamination
  - Detection limits
  - Methodology used

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What is achievable?

- Less than 20 labs in North America can run EPA 1668C and only a few will give detection limits <10 pg/L
- No analytical confidence at 6 pg/L for Total PCB in water let alone brine solutions

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Thank you

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