

# **PCBs and Pesticides in Alaskan Native and Native American Communities: Routes of Exposure and Health Effects**

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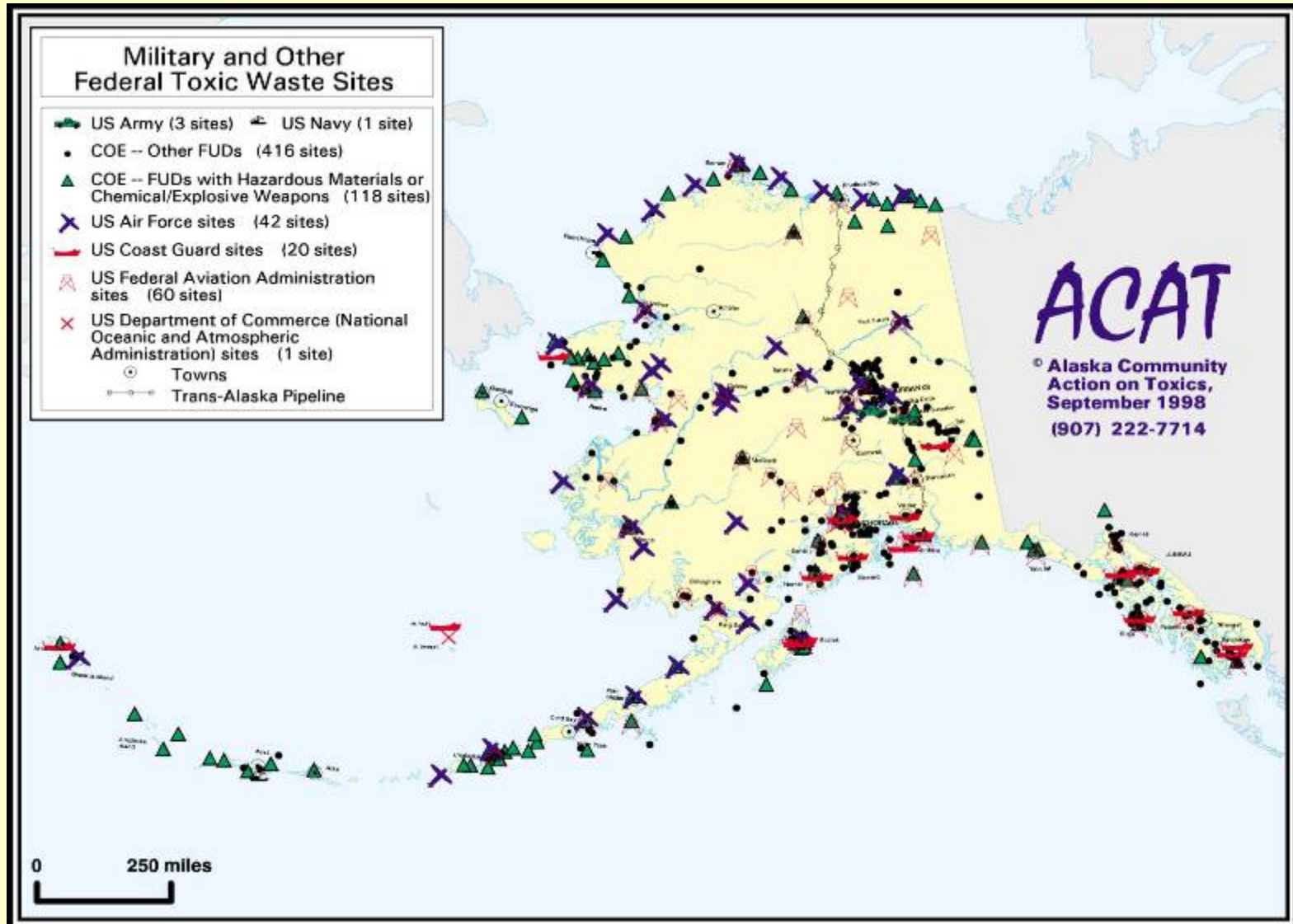
# CHARACTERISTICS OF PCBs

- ☞ Very stable and persistent in animals and in the environment.
- ☞ Tend to bio-accumulate in the food chain, especially in fat.
- ☞ Lower chlorinated PCBs are more volatile and water soluble.
- ☞ Major source of human exposure is from food, especially fish.
- ☞ The polar regions of the earth are highly contaminated via atmospheric transport.

# Diseases of Concern

- **Cancer**
- **Immune Suppression → increased infectious disease, increased cancer**
- **Neurobehavioral effects → reduced IQ, antisocial behavior, poor memory, increased mental illness**
- **Hypothyroidism → overweight, tired, lacking energy**
- **Diabetes**
- **Cardiovascular disease → heart attacks, hypertension, high serum lipids**
- **Disruption of sex steroid system → infertility, birth defects of reproductive organs, early menarche, endometriosis**
- **Developmental abnormalities → low birth weight, birth defects**
- **Arthritis, skin disease**

# Military and Other Federal Toxic Waste Sites



# Contaminants in the North

- The north has become a hemispheric sink for pesticides and other industrial chemicals
- Northern food webs favor the deposition and retention of persistent, bioaccumulative toxics
- Contaminants in the north threaten the health of peoples that rely on traditional diets of fish and marine mammals
- Global warming enhances the mobilization and transport of contaminants from local and distant sources



# Health of Arctic Children Threatened

***“Alaska Native infants have a much higher rate of hospitalization for infection than any other group of U.S. infants... Prenatal exposure to contaminants, which are known to affect the developing immune system, could play a role, and that possibility is now being examined.”***



—Dr. Jim Berner, pediatrician, Alaska Native Tribal Health Consortium

# Adverse Birth Outcomes Associated with Open Dumpsites in Alaska

**Mothers residing in villages with high hazard ranking were:**

- 43% more likely to have a low birth weight baby
- 45% more likely to give birth prematurely
- More likely to have babies afflicted with intrauterine growth retardation

Gilbreath, S. and Philip Kass. 2006. *American Journal of Epidemiology*.





**“Climate change is occurring faster than people can adapt. [It] is strongly affecting people in many communities, in some cases threatening their cultural survival.”**



# More Impacts



**Melting permafrost exposing military debris**



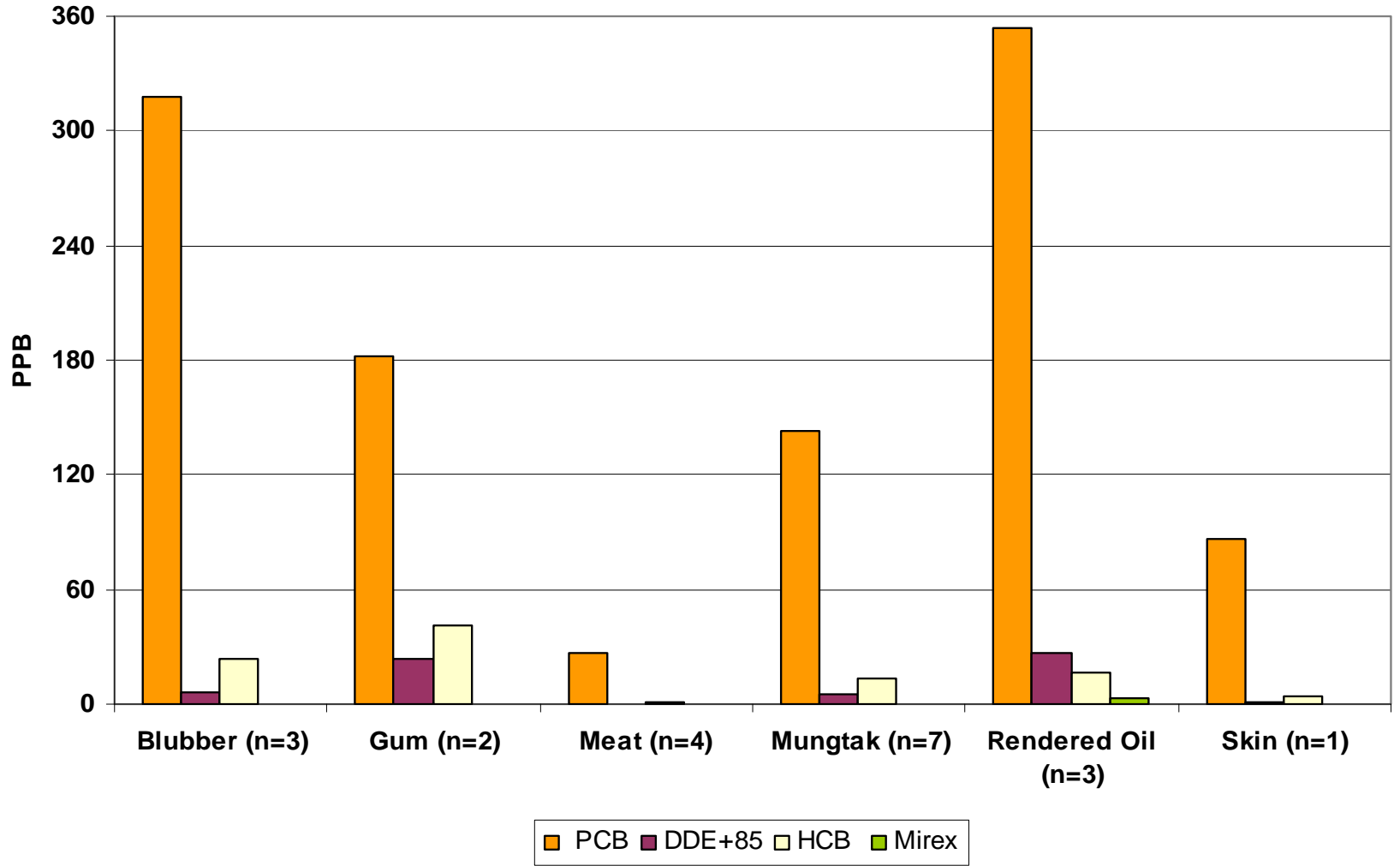
**Glacial melt, McCall Glacier**



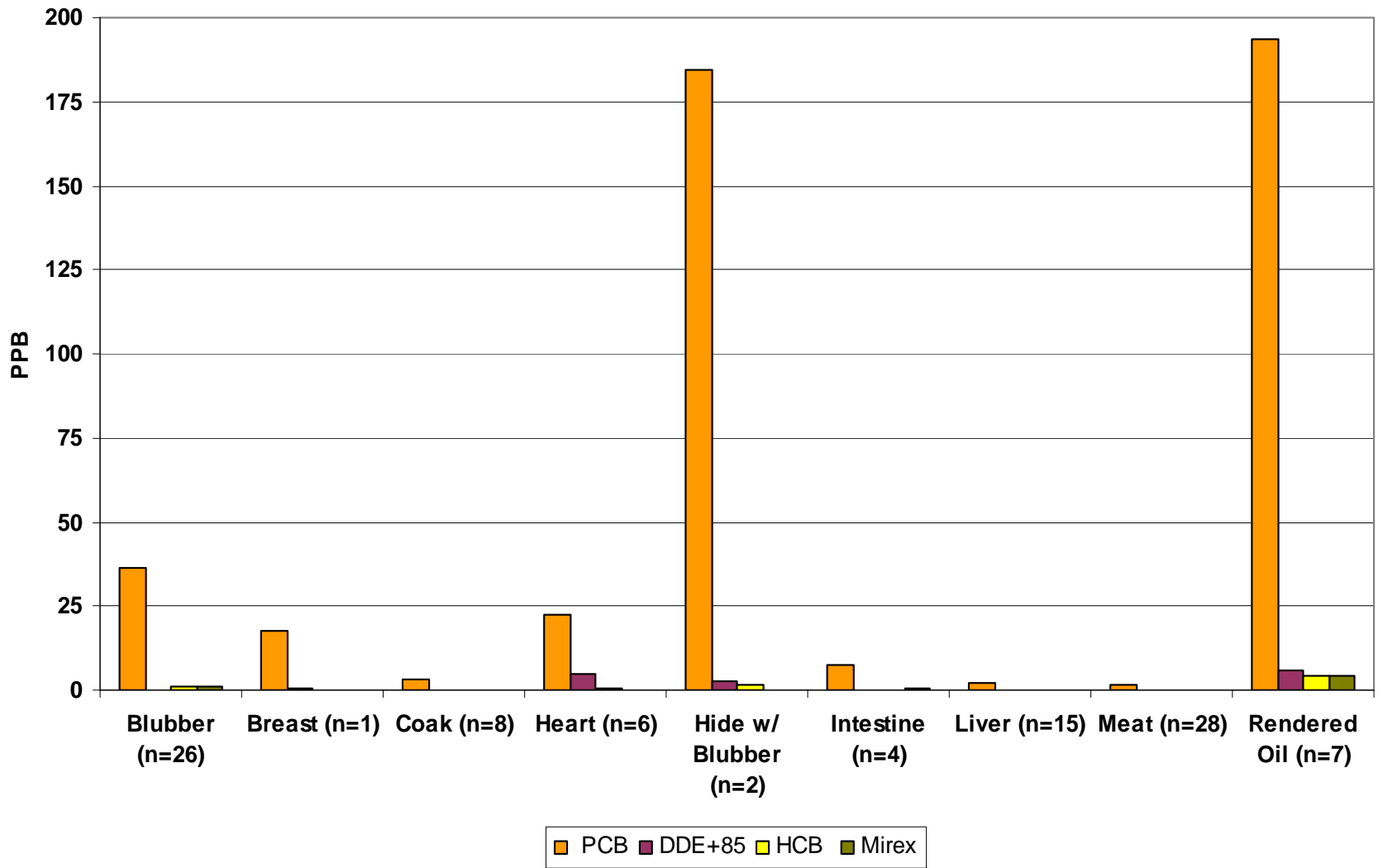
# St. Lawrence Island, Alaska

- The residents of St. Lawrence Island are Siberian Yupiks.
- Their traditional diet consists primarily of marine mammals, whale, seal and walrus, and occasionally polar bear. Blubber and rendered oils are consumed daily.
- The fats of these marine mammals are highly contaminated with PCBs.

# Bowhead Whale



# Walrus



# USEPA Guidelines for Fish Consumption

- PCB levels that are safe for unlimited consumption = 1.5 ppb.
- PCB levels that trigger a “do not eat” advisory = 94 ppb.
- All of the rendered oils trigger a “do not eat” advisory.
- Even the meats trigger an advisory for restricted consumption.
- There is nothing else to eat in this community.

# PCB Levels

St. Lawrence Island = 4,600 ppt

Akwesasne Mohawks = 4,380 ppt

US Background = < 900 ppt

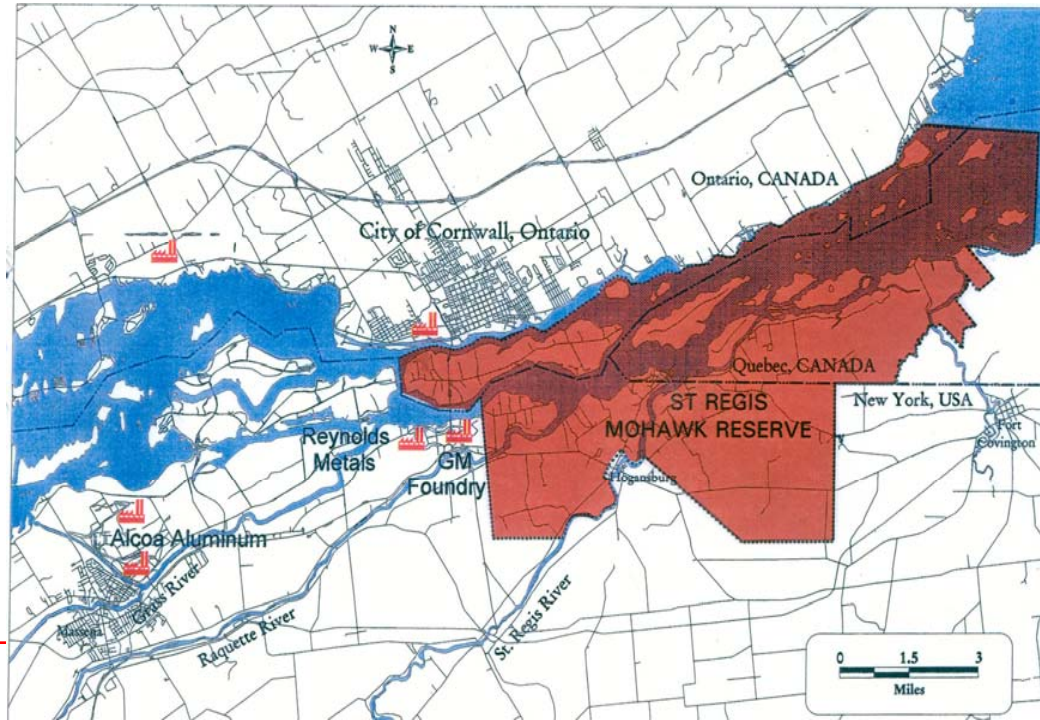
# Population Characteristics - Site History

## • Akwesasne Mohawk Nation:

- A Native American community of nearly 10,000 people.
- Comprises approximately 28,000 acres in New York, Ontario, and Quebec.
- Home for many generations of Mohawk people; community members place special value on the environment and engage in subsistence activities (fishing, hunting).

## • Industrial sites:

- General Motors - Central Foundry Division (GM-CFD). A US Federal Superfund Site in 1983.
- ALCOA  
New York State Superfund Site.  
Upstream from the GM plant.
- Reynolds Metals, Inc.  
New York State Superfund Site.



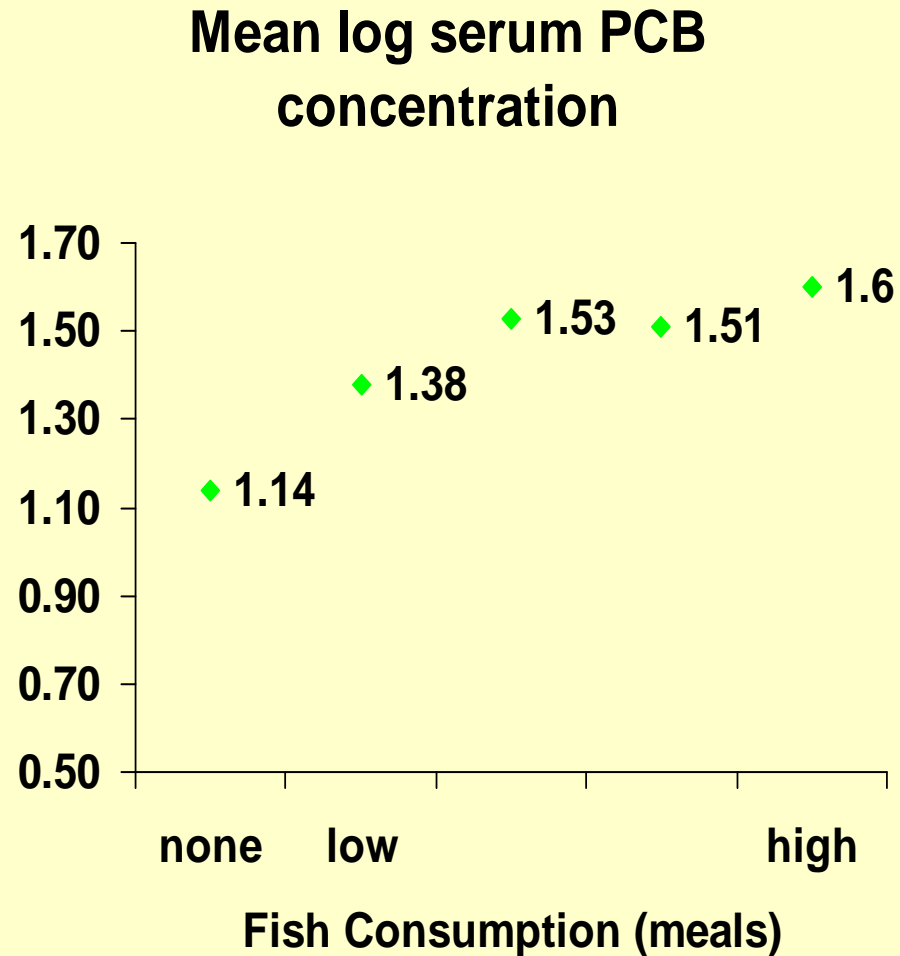
# Serum PCB level and Fish Consumption

## (univariate analysis)

- Local fish
- Frequency of fish servings  
(per week, month or year)
- 3 time periods
- 11 fish species
- Usual serving size in lbs
- Calculated cumulative no. fish meals & lbs consumed
- 375 (93.5%) - ate fish

Mean: 1,941 meals (1-27,724)

Mean: 1,177 pounds (0.25-12,948)



# Polychlorinated biphenyls (PCBs) among Adolescents of the Akwesasne Mohawk Nation, n=117 (in ppb).

| Toxicant                                   | Geometric Mean | Median | Maximum |
|--|----------------|--------|---------|
| Total PCBs                                 | 1.81           | 1.72   | 4.74    |
| PCB congeners with 5-9 chlorines           | 1.10           | 1.10   | 3.03    |
| Total mono-ortho substitution (5-9Cl)      | 0.12           | 0.11   | 0.35    |
| Total di-ortho substitution (5-9Cl)        | 0.64           | 0.65   | 1.72    |
| Total tri/tetra ortho substitution (5-9Cl) | 0.29           | 0.28   | 1.41    |
| PCB congeners with 1-4 chlorines           | 0.69           | 0.62   | 1.98    |
| Total mono-ortho substitution (1-4Cl)      | 0.27           | 0.25   | 0.85    |
| Total di-ortho substitution (1-4Cl)        | 0.27           | 0.2    | 0.86    |
| Total tri/tetra ortho substitution (1-4Cl) | 0.07           | 0.07   | 0.16    |

Source: Schell, LM; DeCaprio, AP; Gallo, MV; Hubicki, L; The Akwesasne Task Force on the Environment. Polychlorinated biphenyls and thyroid function in adolescents of the Mohawk Nation at Akwesasne. In: *Human Growth from Conception to Maturity*. Smith-Gordon: London, UK. 2002.



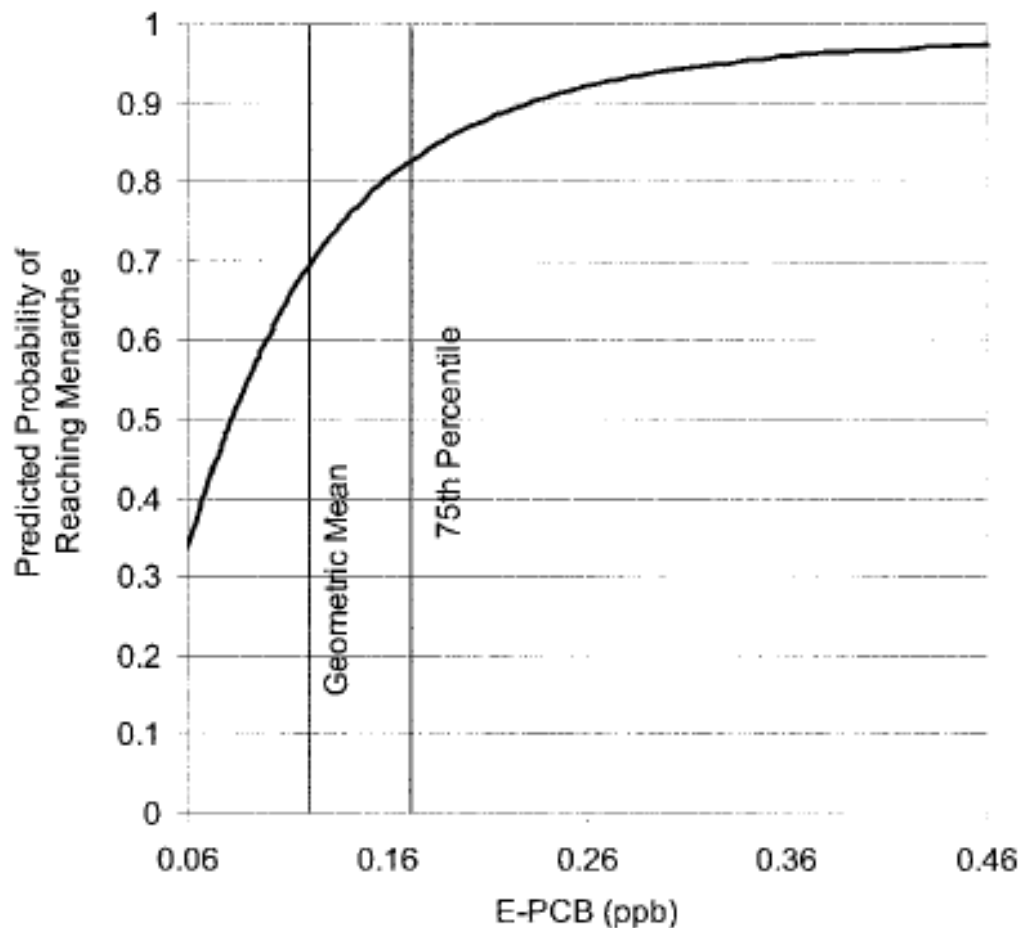


Fig 2. Predicted probability of 12-year-old Mohawk girls reaching menarche at different levels of E-PCB, with all other variables held constant at their respective means (calculations based on the mean-centered model in Table 4). The vertical lines indicate the geometric mean (0.12 ppb) and 75th percentile (0.17 ppb) of E-PCB levels.

- **Table 3.** Levels of serum testosterone in relation to serum concentrations of PCBs in Mohawk men.

| Median (ng/dL)  | Wet-weight measurement <sup>a</sup> |                   | Lipid-adjusted measurement <sup>b</sup> |
|-----------------|-------------------------------------|-------------------|---|
| Analyte         | [OR (95% CI)]                       |                   | [OR (95% CI)]                           |
| PCB 74          |                                     |                   |   |
| Lowest tertile  | 574                                 | 1.00              | 1.00                                    |
| Medium tertile  | 474                                 | 0.51 (0.21–1.20)  | 0.52 (0.22–1.19)                        |
| Highest tertile | 406                                 | 0.28 (0.08–0.90)* | 0.29 (0.09–0.93)*                       |
| PCB 99          |                                     |                   |   |
| Lowest tertile  | 583                                 | 1.00              | 1.00                                    |
| Medium tertile  | 486                                 | 0.50 (0.22–1.21)  | 0.64 (0.30–1.36)                        |
| Highest tertile | 421                                 | 0.33 (0.11–1.00)* | 0.41 (0.14–1.07)                        |
| PCB 153         |                                     |                   |   |
| Lowest tertile  | 551                                 | 1.00              | 1.00                                    |
| Medium tertile  | 499                                 | 0.48 (0.17–1.35)  | 0.52 (0.19–1.39)                        |
| Highest tertile | 431                                 | 0.15 (0.03–0.69)* | 0.19 (0.05–0.77)*                       |
| PCB 206         |                                     |                   |   |
| Lowest tertile  | 543                                 | 1.00              | 1.00                                    |
| Medium tertile  | 517                                 | 0.63 (0.26–1.53)  | 0.58 (0.22–1.33)                        |
| Highest tertile | 438                                 | 0.20 (0.06–0.67)* | 0.27 (0.08–0.83)*                       |

- <sup>a</sup>All ORs were adjusted for age, BMI, total serum lipids, and concentrations of HCB, DDE, and mirex. <sup>b</sup>Toxicant concentrations in serum lipids. All ORs were adjusted for age and BMI, as well as concentrations of HCB, DDE, and mirex. \*Statistically significant ( $p < 0.05$ ).

# Cognitive Measures

- **WJ-R Woodcock Johnson: Revised** (long term retrieval, short term memory, processing speed, auditory processing, visual processing, comprehension-knowledge, fluid reasoning).
- **TOMAL Test of Memory and Learning** (verbal memory, non-verbal memory, composite memory, delayed recall).
- **RPM Ravens Progressive Matrices: Standard Form** (non-verbal problem solving).

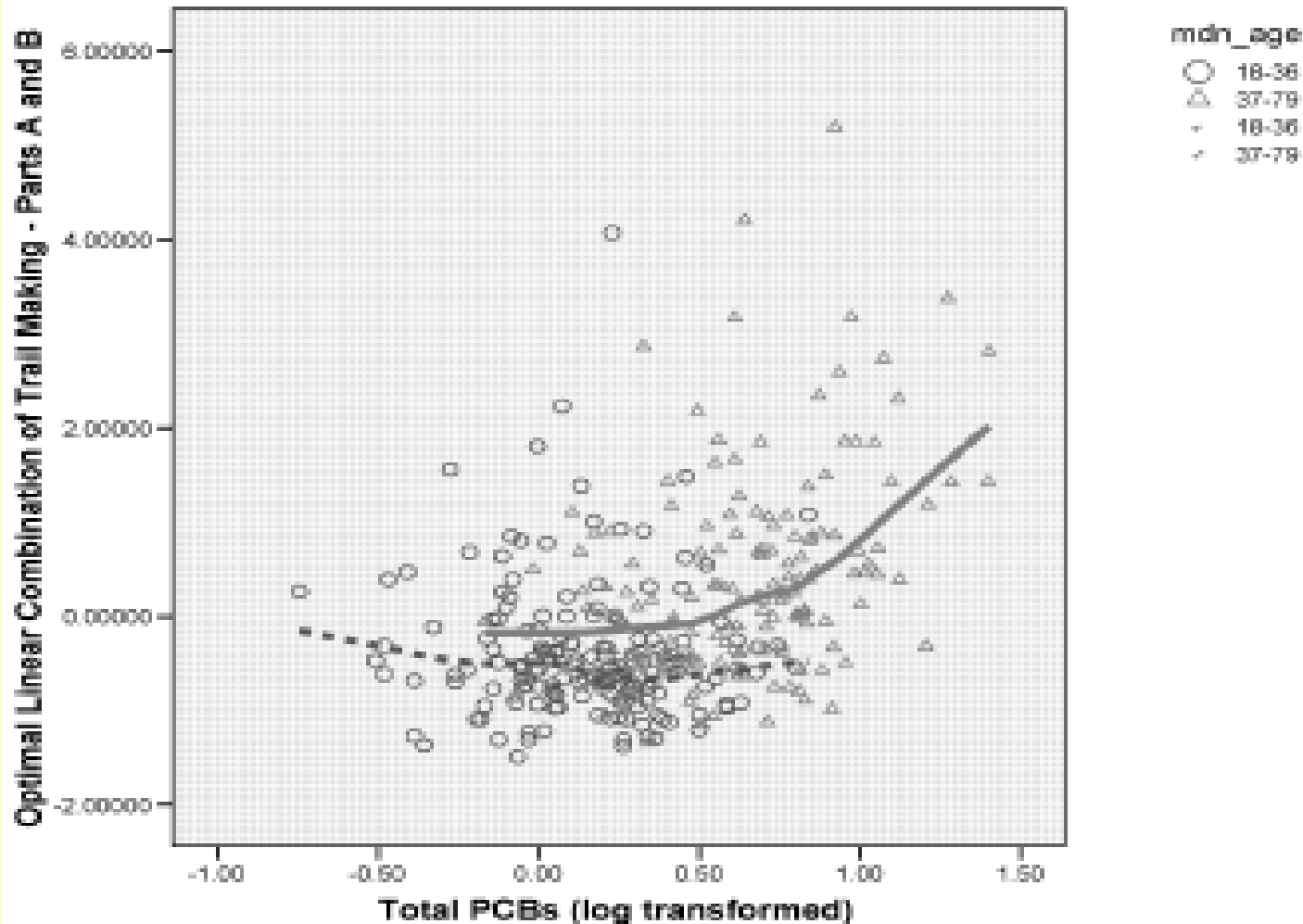
# Results: Correlations between PCBs and Cognitive Variables

(Controlling for confounding variables)

Coefficients with \* are statistically significant ( $p < .05$ ) all others listed are significant at ( $p < .1$ ).

| <b>PCB Grouping Variables</b> | <b>Total Sample<br/>N=236</b>   |
|-------------------------------|---|
| <b>50% Detect</b>             | Delayed Recall (-0.13)*<br>Long Term Retrieval (-0.19)*<br>Comprehension Know. (-0.14)*<br>Auditory Processing (-0.11)  |
| <b>75% Detect</b>             | Delayed Recall (-0.14)*<br>Long Term Retrieval (-0.18)*<br>Comprehension Know. (-0.13)*<br>Auditory Processing (-0.11)  |
| <b>Highly Chlorinated</b>     | Delayed Recall (-0.14)*<br>Long Term Retrieval (-0.19)*<br>Comprehension Know. (-0.13)*                                 |
| <b>Persistent PCBs</b>        | Delayed Recall (-0.15)*<br>Long Term Retrieval (-0.16)*<br>Comprehension Know. (-0.12)<br>Auditory Processing (-0.114)* |

# Cognitive Function in Adults in Relation to PCB Levels



# General Conclusions – Cognitive Function

- The levels of PCBs in Mohawk adolescents do not indicate high current exposure. However, there are statistically significant decrements of cognitive function in relation to PCB exposure. The relationships, although small, indicate that there may be subtle negative effects of PCB exposure occurring at PCB concentrations present in the general population.
- Adults also have deficits in cognitive function in relation to serum PCB levels. What is most striking is that there appears to be a threshold concentration of about 2 ppb – a level very commonly found in the general population!

**Table 3. Association between diabetes, wet-weight and lipid-adjusted total PCBs, mirex, HCB and DDE after adjustment for age, gender, body mass index and smoking status in Mohawk adults.**

|            | <b>Tertile</b> | <b>Odds Ratio<br/>(95% CI)<br/>Wet Weight</b> | <b>Odds Ratio<br/>(95% CI)<br/>Lipid Adjusted</b> |
|------------|----------------|---|---|
| Total PCBs | Lowest         | 1   | 1   |
|            | Medium         | 2.15 (0.80 – 5.80)                            | 1.87 (0.79 – 4.44)                                |
|            | Highest        | 3.9 (1.46 – 10.43)                            | 3.29 (1.42 – 7.64)                                |
| Mirex      | Lowest         | 1   | 1   |
|            | Medium         | 1.21 (0.57 – 2.58)                            | 0.82 (0.40 – 1.7)                                 |
|            | Highest        | 0.98 (0.45 – 2.12)                            | 0.89 (0.43 – 1.82)                                |
| HCB        | Lowest         | 1   | 1   |
|            | Medium         | 0.94 (0.33 – 2.67)                            | 2.64 (1.01 – 6.87)                                |
|            | Highest        | 6.22 (2.29 – 16.94)                           | 6.79 (2.65 – 17.44)                               |
| DDE-85     | Lowest         | 1   | 1   |
|            | Medium         | 1.83 (0.65 – 5.19)                            | 2.44 (0.87 – 6.81)                                |
|            | Highest        | 6.43 (2.25 – 18.37)                           | 6.79 (2.65 – 17.44)                               |



## CONCLUSIONS

**PCBs are present in high concentrations in many indigenous people in the US. They increase the risk for a variety of diseases.**

INDEX STOCK IMAGERY

US indigenous people suffer disproportionate exposure to environmental contaminants from industrial waste and military sites and through diet and traditional life-style.

However the levels of contaminants causing these elevated risks of disease are within the range present in the general population.

